Editorial Staff
New York
V. T. Boughton
W. G. Bowman
C. S. Hill
F. W. Herring
H. W. Richardson

Engineering News-Record

A Consolidation of Engineering News, Engineering Record
The Sanitary Engineer, and The Contractor
F. E. SCHMITT, *Editor*

Editorial Staff
Chicago
W. W. De Berard
San Francisco
N. A. Bowers
J. I. Ballard

Willard Chevalier
Publishing Director

Contents for February 16, 1933

VOLUME 110, NUMBER 7

Copyright, 1933, by McGraw-Hill Publishing Company, Inc.

Super-Roads to Serve a Pleasure-Land..... 209
By CHARLES V. POWELL

Concrete Pavement Failures Due to High-Lime Cement..... 212
By IRA PAUL

Rebuilding Fifth St. Bridge at Augusta, Ga..... 214
By SEARCY B. SLACK

Welded Alloy Bucket Lips Cut Trenching Costs..... 215
By GEORGE SYKES

Comprehensive Storm Sewer System for Dallas, Tex..... 216

X-Raying Welded Steel Plates Up to 4-In. Thickness..... 220
By R. E. HILLER

Record Cement-Pumping Lift at Pine Canyon Dam..... 221

Hospital Addition Introduces Welding in San Francisco..... 222

Shell of Concrete Standpipe Pre-Stressed by Steel Hoops..... 224
By J. A. JENSEN

Plan for Rio Grande Rectification..... 226

Book Reviews.....228 Letters.....229 Editorials.....230

News.....232 Equipment.....237

Published every Thursday. Price 25c. per copy. Subscription, domestic, Central and South America, $5 per year. Canada, including duty, $7.50. Foreign $9 or 45 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable address: "MCGRAWHILL, New York." Member A.B.P. Member A.B.C.

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.; Los Angeles. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treasurer; Mason Britton, Vice-President; Edgar Kobak, Vice-President; H. C. Parmelee, Vice-President and Editorial Director; Harold W. McGraw, Vice-President; C. H. Thompson, Secretary.

Safe Cost Cutting in Bridge Repairs

PONTOON TRANSFER BRIDGE
NEW YORK CENTRAL R.R., N. Y. (Repaired by arc welding)

By the Application of LEAKE BRIDGE REPAIR METHODS

Properly designed welded bridge repair work withstands impact and torsion

We repaired this transfer bridge by arc welding three years ago.

Previously frequent repairs to riveted joints was necessary. Since the repairs were made, the bridge has stood the impact of car floats, the twisting strains of partial loading—without failure.

The economies resulting from the use of structural welding may be safely obtained when both design and performance are handled by experienced men.

The LEAKE *and* NELSON CO.

CONTRACTING • CONSULTING • STRUCTURAL • WELDING

Engineers

Main Office and Works
203 Ash St., Bridgeport, Conn.

New York Office—Room 1845
Grand Central Terminal

Pennsylvania Representative—Snow-Weaver Industrial Management, Inc., Harrisburg, Penna.

Licensee under U.S.A. patents and patents pending controlled by A. G. Leake

Engineering News-Record

Vol. 110 New York, February 16, 1933 No. 7

Super-Roads to a Pleasure-Land	209	Welded Hospital in San Francisco	222
Concrete Pavement Failures, N. Y.	212	Concrete Standpipe for Minneapolis	224
Rebuilding Augusta, Ga., Bridge	214	Rio Grande Boundary Rectification	226
Welded Alloy Bucket Lips	215	Book Reviews	228
New Storm Sewers for Dallas, Tex.	216	Editorials	230
X-Raying 4-in. Welded Plates	220	News of the Week	232
Bar Joist Reinforcing in a Dock Wall	221	Equipment and Materials	237

Super-Roads to Serve a Pleasure-Land

First of three articles describing a system of super-highways in Queens Borough to provide gateways from New York City to the girdle of parkways embracing the beach, sports club and resort areas of Long Island

By Charles V. Powell

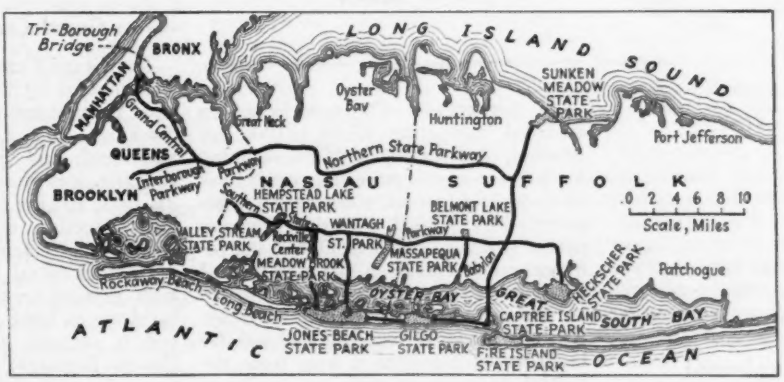
Engineer in Charge, Queens Topographical Bureau, Long Island City, N. Y.

LONG ISLAND forms the great playground of New York City. To get at it, all must enter through the gateway of the city borough of Queens. This calls for roads far beyond the street types of a busy city. So the borough of Queens is building roads of a kind and character seldom associated with normal city thoroughfares, and in numbers that have no equivalent elsewhere in the world. This activity is a story of roads—of wide costly super-roads having no cross-turns, no intersecting travel and no red lights. It is a story of great acquisitions of expensive rights-of-way for direct routes, of intricate arrangements for interchanging, separating and distributing traffic and of many bridges and underpasses.

The prologue

Long Island has an area of 1,373 square miles, including 179 square miles within New York City (Brooklyn and Queens). The island is 120 miles long and has 200 miles of magnificent beaches. Its extreme breadth, over outlying beaches, is 24 miles; the prevailing width is about 15 miles. In 1932 the population of Long Island was 4,103,639—about one-third of the total of New York State, and surpassed by only seven other states. In the decade 1920-1930 only two states exceeded Long Island's 50.7 per cent rate of growth—Florida with 51.6 per cent, and California with 65.7 per cent.

Great super-highway loop connecting New York City with pleasure resorts and beaches of Long Island.



This great growth, coinciding with the great increase of motor transportation and the mushroom growth of country clubs and beach resorts, brought with it the need of highways along which autos might travel without encountering any form of traffic delay—no red lights, no left turns and no cross-traffic from anywhere.

From the purely engineering side, this demand is simple to meet. Grade separations, with convenient means of access from one route to another, are easily designed. But when these have to be made in a territory already well filled with people—homes, schools, stores, etc.—the matter of finance lays a heavy hand on the work of the engineer, and great ingenuity is called for to achieve the result without incurring prohibitive costs.

At this juncture the state of New York, through the Long Island state park commission and the state highway department, projected itself into the picture. Conditions were imposed that would tend to make the resulting highways a beautiful feature of the landscape. No state money was to be spent on mere traffic thoroughfares running through a canyon of brick and concrete apartments and stores. Adequate space must be set aside on both sides

of the roadway for parkway planting. Grass and shrubs, trees and flowers must form the setting. Generally speaking, the space demanded is 100 ft. on each side of the main road, though local conditions sometimes modify this a bit.

Another requirement is that there shall be no crossing of these superhighways, at grade, by any other roads. They must be free from left turns—the bane of a heavily used route. Consequently, they can be operated without the effect of traveling through a veritable park all the way. These three great parkways across Queens, itself a city of well over 1,100,000 inhabitants, will cost, it is estimated, about $12,000,000 in addition to the land values. Most of the necessary land has already been acquired by the city.

Of this $12,000,000 the state legislature has already appropriated $2,000,000 toward construction of Grand Central Parkway—the first link, within the city,

Main thoroughfares of Queens Borough as developed to connect with super-highway loop on Long Island.

a red light over the whole length. So effective is this means of promoting progress along them that one route, now planned and already largely under construction, will permit cars to travel more than 100 miles without any red lights, any left turns or any cross-traffic at any point.

Improvements planned

In Queens Borough alone 24 miles of this sort of parkway road has been planned, and 7 miles is being built this year, with facilities in each road for from four to six lanes of high-speed motor traffic. The landscaping will give of the new system. Contracts have been awarded amounting to $1,440,000 for grading, landscaping and constructing bridges (to pass intersecting roads over or under); this work was virtually completed during 1932. Engineering expenses will total about $200,000; the remainder ($360,000) will be used toward grading for a westward extension, to be known as Interborough Parkway. Recently a sum of more than $1,000,000 has been obtained, as a loan from the federal government, with which Grand Central Parkway will be paved, and connection will be made at its eastern end with Northern State Parkway, under construction through Nassau County and into Suffolk County to the east.

Surveys to extend the western end of this Grand Central Parkway in two directions have been provided for by a state appropriation of $75,000. With this appropriation the highway engineers have designed the bridges also. One route will be, in general, northwest to lead to the new Triborough Bridge now being built, which connects Queens Borough with the Bronx across Hell Gate, and has a spur into 125th St., Manhattan. The other route, running west into Brooklyn, and connecting into the Eastern Parkway, will be the Interborough Parkway. It is understood that the routes covered by these surveys (including the Laurelton Parkway, described later) will involve an additional outlay by the state of $5,000,000 on the parkway program, in five annual installments of $1,000,000 each.

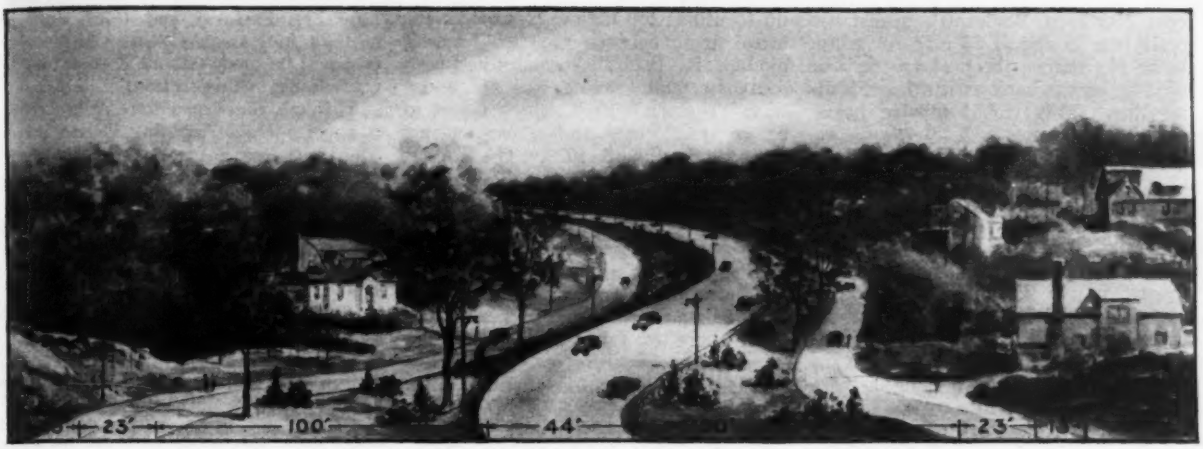
Included in the general plans is another super-highway in the southern part of Queens, connecting Brooklyn with the Southern State Parkway, already in use for 15 miles or more across Nassau County. This is the great route to the state's new bathing park at Jones Beach. Sunrise Highway, the Queens Borough section of this through-route, runs along the line of the water conduits that have long supplied Brooklyn with water from the east. This has a width of 250 to 1,000 ft., including the express road in the center (already in use, but with most of the grade separations still to be made), service and access roads at each side, and the broad areas, which eventually will be landscaped, adjoining the speed road.

Preparation of the right-of-way maps for these highways has been in progress in the Queens Topographical Bureau since the spring of 1931. These are the general plans for the highways, showing the land acquired, the width and alignment, grades of the roadways, locations of bridges, service roads and access drives, and such other changes in the city plan as may be necessary to provide access to local areas along the route.

Grand Central Parkway

For Grand Central Parkway the map was adopted by the Board of Estimate and Apportionment of the city of New York on June 5, 1931. Title to the additional land required for its construction was vested in the city on July 21, 1931, and the first contract for grading a section of the parkway was awarded in September of the same year.

Grand Central Parkway follows the high ground forming the longitudinal backbone of Long Island. At its eastern end it includes the highest point in Queens Borough, and from some locations along its route both Long Island Sound to the north and Jamaica Bay to the south may be seen. It extends from Queens Boulevard, at Kew Gardens, in the heart of Queens, to the Nassau County line, a distance of more than 7 miles. It is being paved with



Typical arrangement of parkway with landscaping and parallel service roads.

reinforced concrete 44 ft. wide, to accommodate four lanes of traffic. For more than half its length the grades will not exceed 2 per cent, and the maximum will be only 3½ per cent. These grades will be connected by vertical curves from 200 to 400 ft. long. With the exception of a single tangent, 1,000 ft. long, its alignment will consist of curves having a radius of not less than 2,000 ft.

Thirteen bridges will separate the grades at as many intersecting highways. Several of these have been completed, and the others are actively under construction. The four most western bridges will carry the cross-roads over the parkway; eight of the nine in the easterly portion will carry the parkway over the intersecting highways. Two other crossings, one an overpass and one an underpass, are designed for future construction, when local needs are built up to the point of requiring them.

Service roads are provided on both sides, except where the parkway is embraced by city-owned park lands, as in the case of Hillside Park and Alley Park, or is bounded by New York state property, as occurs north of the Creedmoor State Hospital. Wherever possible, the service roads are separated from the main parkway road by 100 ft. of landscaped area. Service roads have a minimum width of 43 ft., consisting of a 28-ft. pavement and, on one side only, a 15-ft. sidewalk space.

Access drives between the parkway and the service roads are provided at intervals of a half mile or less. These permit access, as well, between the parkway and the residence areas contiguous to the service roads. Separate outlets are provided for traffic entering and that leaving the parkway. For one-way traffic these access drives have a minimum width of 22 ft.; for two-way traffic, 32 ft. These approaches are subject to few grades in excess of 4 per cent, and none over 6 per cent. Each access drive has been designed to fit the special local traffic and topographical conditions encountered. Hence they vary from straight ramps to a conventional cloverleaf design.

In the area just east of Queens Boulevard plans have been made to separate the grades between the new parkway extensions to the west and to the north; also between the northerly parkway extension and the westbound service road of Union Turnpike. This calls for three additional bridges in this section. (The early designs called for four, but careful study eliminated one.) The underpass at Queens Boulevard is being broadened from its original planned width of 40 to 80 ft., thus permitting it to include the east- and west-bound express roadways of Union Turnpike, as well as the 40-ft. center strip for the parkway. This is now well along in construction. In addition, side ramps will be provided for interchange of traffic between Queens Boulevard and the service and express roads along Union Turnpike.

A comprehensive system of access drives has been designed for this area, to provide for traffic movements between the two parkways and with Union Turnpike, without any cross-traffic or any left turns. This whole system, involving the crossing of three major arterial highways, one with three main stems, has required a length of more than 3,000 ft., in working out all of the necessary crossings and access facilities. This will be described in some detail in a later article.

Interborough Parkway

Westwardly, the extension of Grand Central Parkway beyond Queens Boulevard runs 4 miles to the line of Brooklyn, where it enters Highland Park and thence reaches Eastern Parkway. This Interborough Parkway line runs, for nearly half its length, through the northerly portion of Forest Park, the largest park in Queens. The paving will have a width of 44 ft., to carry four lines of traffic. Between Forest Park and Highland Park the route lies through Cypress Hills Cemetery. This section has already been graded, and three bridges have been built, all previous to the beginning of state participation in these parkway plans. This portion, 90 ft. wide will have two paved roadways, each 36 ft. wide, separated by an 18-ft. walk or mall.

Including the three bridges in the cemetery, Interborough Parkway will have seventeen bridges, to provide grade separations at all cross-streets and the three railroad crossings. Two additional bridges, on Union Turnpike at railroad crossings, will be built also, for the whole scheme of this improvement includes a section of Union Turnpike west of Queens Boulevard for about a mile beyond its separation from Interborough Parkway.

Triborough Bridge

Maps prepared for the northerly extension of Grand Central Parkway, to connect with the new Triborough Bridge, a distance of 7 miles, have had to be modified in some important particulars. As laid down, the route follows the foot of the slope west of Flushing River, crossing under Northern Boulevard at the southwest "corner" of Flushing Bay. The layout follows the westerly shore line of the bay before turning inland and reaching Astoria Boulevard about 1½ miles east of the Triborough Bridge Plaza. For this 1½ miles it is planned to widen the 130-ft. Astoria Boulevard to 200 ft., to accommodate the additional parkway traffic; and, nearer the bridge to widen it to 300 ft. as other arteries enter. Both express and service roadways are planned along this approach to the new bridge, the former to reach ultimately as high as sixteen parallel lanes of traffic.

That portion of the plan which carries the parkway along the shore of Flushing Bay has struck a snag. This section was routed over what is now water; a fill was to be made, taking material from the bay. It now develops that the material avaliable is totally unsuited to the purpose, and that part of the project has had to be abandoned. Instead this extension may be routed along Astoria Boulevard all the way

from Northern Boulevard, a distance to the new bridge of 3½ miles or more. As an alternative, the parkway may be lifted up on the bank as it skirts Flushing Bay. This would involve heavy property damage.

Sunrise Highway

For many years the city of Brooklyn has had water conduits over a route eastwardly from the Ridgewood reservoirs to a point just within Suffolk County, nearly 25 miles. The water department had lands over this length varying from 250 ft. to more than 1,000 ft. in width. Since consolidation in 1898, when Brooklyn became a part of New York City, title to these lands has rested in New York City, but they have been under the jurisdiction of the water-supply authorities.

In 1919 an active movement sprang up to utilize for highway purposes the broad areas between the two lines of piping. By 1925 all obstacles had been overcome, and grading was put under way. The main road, which is yet to be given adequate width, was opened to traffic on June 8, 1929. The present 40-ft. concrete pavement will be widened to 60 ft. to accommodate six lanes of traffic.

This route has now been designated as the connecting link between the Southern State Parkway—already tapping half-a-dozen state parks on the south shore of Long Island—and the teeming population of Brooklyn—2,560,401 in 1930. More than six miles of Sunrise Highway lies in Queens. Near the city line, at the east, the route connecting with Southern State Parkway separates from the Sunrise Highway and turns northeast. Through the Laurelton Parkway and a new link to be built in Nassau County the connection will be made—about 2 miles of the route lying in this section.

Through the Laurelton Valley there is a considerable building development. This will, for a part of the distance, necessitate placing the service road (on one side of the parkway) beyond a row of houses already in use. By this means the prohibitive damage cost for tearing down the buildings will be avoided.

* * *

IN SUCH a plan for developing ideal road service as is described by Mr. Powell a complex problem is presented by the necessity of interchanging and separating traffic at intersecting and access highways. The difficulties of its solution increase with the physical and land-value limitations set up by the location of the work in city territory as was the case in Queens Borough. Generally each intersection calls for an individual design, and in the next issue Mr. Powell illustrates and explains a number of the designs developed by his bureau. —EDITOR.

Concrete Pavement Failures Due to High-Lime Cement

Records of pavement failures on New York roads checked against cement composition show definitely greater durability with decrease in tricalcium silicate component

By Ira Paul

Associate Laboratory Engineer, New York State Department of Public Works, Albany, N. Y.

VARIOUS articles and reports have been published recently on composition of cements to be used for mass-concrete structures. *Engineering News-Record* has published much such information in its issues of Oct. 6, 13 and 20 and Nov. 10, 1932. The specification requirements for cement for use in the construction of Pine Canyon Dam, Hoover Dam and similar projects have been so formulated as to place particular emphasis on the composition. The percentages of certain undesirable constituents have been limited to eliminate accentuated volume changes and cracking in massive hydraulic structures. To accomplish this, a recommendation has been advanced to control the percentage of tricalcium aluminate and tricalcium silicate compounds.

Growth in lime content

In the investigation of concrete highways and structures in New York State I find failures that have been apparent for several years and that are due to the high-lime portland cements. Tracing back the records of the cements furnished us by the industry since 1910, I find that in most cases there has been a gradual increase in the lime content of the cements, some manufacturers making this change in or about 1924 to meet the increased strength requirements adopted by the American Society for Testing Materials. It is interesting to note that the producers were always one step ahead of the strength-specification requirements for cements. The sales organizations were directing the policies of the industry to produce higher-strength portland cements. To meet this created demand on the basis of strength requirements, there was one of two avenues of approach open to the cement chemist at the plant—namely, to increase the fineness of the cement or to increase the lime content. As a matter of fact both courses were pursued. The finer the cement clinker is ground the faster the hydration of the cement will take place; and, second, the higher the lime content the higher the early strength. By increasing the lime content in the cement there resulted an increase in the percentage of the tricalcium silicate compound.

The researches of Bates and Klein, in Bulletin 78 of the U. S. Bureau of Standards, on "The Properties of Calcium Silicate and Calcium Aluminate Occurring in Normal Portland Cement" point to the conclusions that, "The hydrated tricalcium silicate compound which is present in cement, with its very dense structure composed of gelatinous (collodial) silicate interspersed with crystals of lime hydrate, is probably very susceptible to strains produced by alternate wettings and dryings, colloidal material of this kind being subject to considerable volume change resulting from slight moisture change." This liberated lime is probably the constituent of cement least resistant to the deteriorating influence of weather and water action and also the constituent that is most readily attacked by the destructive agencies of freezing and thawing to which concrete must frequently be exposed. The concrete highway slab is unusually exposed to the destructive agency of the natural elements. Unless it can resist these agencies, deterioration usually follows.

The high-lime portland cements such as are now produced are high in tricalcium silicate, a compound that is acknowledged to produce high early strength but is not conducive to durability. Definite laboratory information and data point to the conclusion that the tricalcium silicate compound exerts its greater influence in its early periods with increased strengths. The rate of strength increase tends to decrease with age, so that eventually the high tricalcium silicate cements are exceeded in strength by cements containing a lower percentage of this compound and a corresponding higher percentage of the dicalcium silicate. The dicalcium silicate compound is one of the most desirable constituents in cement. This compound attains its strength at later periods and is conducive to durability in concrete.

TABLE I—TYPICAL COMPOUND COMPOSITION OF VARIOUS BRANDS OF PORTLAND CEMENT

Brand	Year	Compound Composition C_3S	C_2S
A	1920	28.36	43.77
	1930	55.43	19.37
B	1920	38.29	29.09
	1930	46.19	21.98
C	1920	34.26	37.30
	1930	46.72	27.58
D	1920	37.89	30.57
	1930	49.04	20.14
E	1920	36.75	32.31
	1930	57.10	14.94

Recent laboratory investigations also show that the tricalcium aluminate compound has a certain detrimental effect on concrete. This compound hydrates very rapidly and generates a considerable amount of heat. As a general rule, the greater the tricalcium silicate content the greater the total expansion and shrinkage in concrete.

Table I illustrates the change made by the cement industry in the compound composition of portland cement. It will be noted that in one decade there was an increase from 25 to 100 per cent in the tricalcium silicate compound, within the same brands.

As intimated above, with the introduction of the high-lime portland cements in the construction of concrete highways we find that we are in difficulties on the question of durability of concrete. This lack of durability has been more definitely pronounced in comparatively recent years, probably more so within the last eight or nine years. In some cases the deterioration of concrete pavements has been traced to poor aggregates. There may be a number of other contributing causes, such as design, workmanship and subsoil conditions, but these in my opinion do not constitute the basic trouble. Our engineering and methods of construction have constantly improved with time, but I believe we have not kept up a similar pace in improving the quality of materials. I recently presented a paper before the Highway Research Board on the magnesium sulphate accelerated soundness test for concrete aggregates. I believe this test will aid the testing engineer in determining the quality of aggregates, as it has shown its superiority over the sodium sulphate soundness test tentatively adopted by the A.S.T.M.

TABLE II—CONDITION OF CONCRETE HIGHWAYS WITH VARIOUS TYPES OF CEMENT

Highway No.	Year Built	Composition of Cement C_3S	C_2S	Soundness Test on Fine Aggregates Na_2SO_4*	$MgSO_4$†	Condition of Concrete Highways in 1932
A	1914	21.61	51.88	6.0	15.1	Excellent condition.
B	1920	37.89	30.57	6.8	20.7	Good condition, sound concrete.
C	1922	39.44	29.03	6.8	20.7	Little scaling, somewhat cracked, concrete sound.
D	1923	38.22	35.97	6.8	20.7	Good condition, slightly cracked, sound concrete, little surface scale.
E	1923	43.27	27.46	6.8	20.7	Dead concrete, surface-treated in 1930.
F	1924	43.47	29.89	6.8	20.7	Surface-treated and covered in 1928.
G	1924	43.47	29.89	6.8	20.7	Dead concrete, covered in 1929.
H	1924	44.93	25.43	4.4	39.4	Very bad condition, deteriorated concrete.
I	1924	48.96	22.19	8.7	56.4	100 per cent scaled and deteriorated.
J	1925	41.83	24.54	6.8	20.7	50 per cent surface-treated, disintegrated concrete.
K	1925	41.06	28.37	6.8	20.7	Disintegrated concrete.
L	1926	37.97	36.60	3.5	28.4	Very good condition, sound concrete.
M	1926	41.06	28.37	3.5	28.4	50 per cent scaled and deteriorated concrete.
N	1926	44.93	24.37	5.3	30.1	75 per cent scaled and deteriorated concrete, started to scale two years after being laid.
O	1926	36.22	32.84	7.6	30.1	Very good condition, sound concrete.
P	1927	39.03	35.41	3.1	33.1	Good sound concrete.
Q	1928	53.18	18.22	6.8	20.7	90 per cent scaled and deteriorated.
R	1929	47.37	24.76	6.8	20.7	Considerable progressive scaling, D lines and hollow concrete.
S	1929	49.90	20.08	5.3	30.1	Considerable progressive scaling.
T	1930	48.59	25.56	5.3	30.1	Considerable scaling, 30 per cent surface-treated.

* The New York State specifications in 1931 on Na_2SO_4 soundness test for fine aggregates was 10 per cent loss on five-cycle test.

† No specification requirement yet adopted on $MgSO_4$ soundness test.

Failures checked against cement

Upon examination of our service records of concrete highways and of materials that were used in their construction, we find some very interesting and illuminating information uncovered on how the composition of cement affects the durability of concrete pavements. We find in tracing down the record of one of the most widely used commercial sources of supply of fine and coarse aggregates that this material was used in the construction of more than 30 concrete highways since 1920. Those pavements constructed after 1923 have been covered over or surface-treated with bituminous materials or are in such bad condition that immediate attention will be necessary to save them, while those constructed prior to that date are in relatively sound condition with but little surface scaling or disintegration.

We have found that the failure of concrete as far as materials are concerned is due to the disintegration of the mortar rather than the coarse aggregate. This disintegration manifested itself first in the form of surface scaling, followed by progressive scaling and D lines. These D lines or lines of disintegration usually appear on the edge of the concrete slab and then travel toward the center. The following is a partial service record and depicts actual conditions of some of the concrete pavements studied in New York State.

Table II of results and data on materials and service records indicates at first glance one very important and outstanding fact—namely, that there is a direct relationship between the type of cement and durability of concrete. By type of cement is meant the potential compound composition with particular emphasis on the percentages of tricalcium silicate and dicalcium silicate compounds. It is evident that the durability of the concrete pavements is directly proportional to the percentage of tricalcium silicate in the cement: the lower the proportion of tricalcium silicate present in the cement the greater the durability; and vice-versa, the greater the percentage of tricalcium silicate the less the durability.

One of the oldest roads built in the western part of New York State was constructed in 1914 with a cement having 21.6 per cent tricalcium silicate. Its design shows a thickness of only 5 in., reinforced with very light steel. It covers a stretch of over 3 miles and carries a tremendous amount of heavy traffic, leading to one of the main arteries of one of the largest cities in New York State. The concrete is in excellent condition, as indicated in highway A, Table II. The concrete road indicated by B, Table II, constructed in 1920 with a cement containing 37.8 per cent tricalcium silicate, is also in good condition. Highway C, Table II, shows a road in which the cement had 39.4 per cent tricalcium silicate. There is a slight evidence of surface scaling, but otherwise it is in sound condition. Note the difference of those concrete roads constructed with the higher lime cements and the same aggregates.

A concrete road constructed in 1923 with cement having 43.2 per cent tricalcium silicate was surface-treated with bituminous material in 1930; another road built in 1924 with a cement containing 43.4 per cent tricalcium silicate was surface-treated in 1928; and another road built in 1928 with a cement containing 53.1 per cent tricalcium silicate has a record showing 90 per cent scaling and deterioration.

In a different part of New York State we find similar results. In 1926 two roads were constructed with the same aggregates and two types of cements. One road had a cement containing 37.9 per cent tricalcium silicate. This pavement is in excellent condition. In the same section under exactly the same conditions another was built with a cement containing 41 per cent tricalcium silicate. Examination of service records shows this latter road has scaled and deteriorated. Such examples can be duplicated in practically every section of our state.

Conclusion

As I see the problem, the question of increasing the life of concrete roads can be solved from the cement angle through the production of low-lime cements in which the tricalcium compound is below 40 per cent. This would correspondingly increase the percentage of dicalcium silicate, a desirable compound known to give longer life and durability in concrete structures. I am of the opinion that we can and should construct concrete highways that will give us considerable longer service with lower lime cements and sound aggregates.

This article expresses the personal views of the writer and was written as a result of a very intensive study of laboratory test data on materials, of field observations and of a personal check-up of service records on concrete highways in New York State. The article does not necessarily represent the official views of the New York State Department of Public Works.

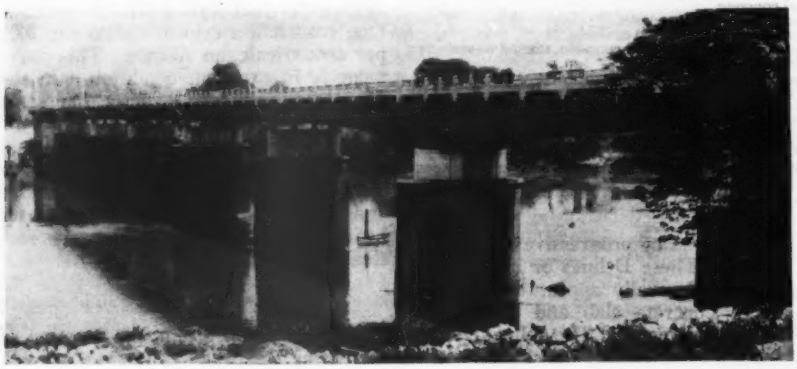
Rebuilding Fifth St. Bridge at Augusta, Ga.

Plate-girder spans designed as cantilevers replace old through trusses over Savannah River

By Searcy B. Slack
Bridge Engineer,
State Highway Board of Georgia, Atlanta, Ga.

FOLLOWING the extreme high water in the Savannah River at Augusta, Ga., in September and October, 1929, which seriously damaged the old Fifth St. bridge and its approach fill, plans were undertaken to construct a new bridge. This new structure, now open to traffic, involved a number of novel features in design and construction such as protection and re-use of the old brick piers and the use of cantilever deck-plate girders. The bridge provides a river opening 260 ft. wider than the old bridge and has an underclearance sufficient to pass a flood with a gage of 52.5 ft., as compared to the highest recorded gage of 46.3 on Sept. 27, 1929.

Fig. 1—New Fifth St. bridge, Augusta, Ga., consists of cantilever plate girders carried on concrete extensions of old brick piers. New bridge increases floodway opening materially.



Also in the new project 1,200 ft. of the approach fill is replaced by a flood-relief bridge of concrete deck girders.

The old bridge consisted of five 120-ft. through Pratt trusses, a 240-ft. swing span and a 90-ft. low-truss span. The spans carried a wood floor with a roadway width of 19 ft., and there were two sidewalks outside the trusses. The old brick piers, built in 1888, were founded on wood grillages supported by wood piles. An inspection of the piers by a diver after the 1929 flood showed that the footings were in good condition with the exception of some scour around the pivot pier and one of the end rest piers. The condition of the old brick masonry was excellent.

In view of the substantial saving possible by using the existing six brick piers, plans were worked out to place heavy riprap around the pier footings, backfill the scoured area with gravel and sand, and then to protect this backfill by additional heavy riprap. The plan of backfilling around the piers is shown in Fig. 2. The piers were raised by adding concrete caps so as to place the new steel superstructure well above extreme high water (Fig. 1).

Although the old bridge carried a swing span, this span had never been opened since its construction, the landing for river boats at Augusta being located about 200 ft. down from the bridge. The first tentative layout of the new bridge, therefore, did not contemplate providing a drawspan, but after a hearing the War Department required that such a span be included.

As the plans contemplated using the old brick piers with fairly high loads on the wood piling, there was a possibility of slight settlement of the piers under the load of the new superstructure. With this in mind it was decided not to use continuous spans but to use

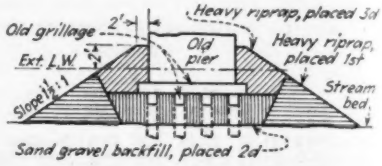


Fig. 2—Backfill around old brick piers strengthened and protected them sufficiently so that they could be used for the new structure.

a cantilever layout in which slight settlement of one of the piers would not cause overstressing of the steel girders. The arrangement of the deck-plate girders with cantilever arms and suspended spans and some details are shown in Fig. 3.

Construction

One of the most difficult problems encountered in the construction of the bridge was proper provision for deflection of the spans under the load of the concrete floor and sidewalks. The order of pouring the concrete deck, given on

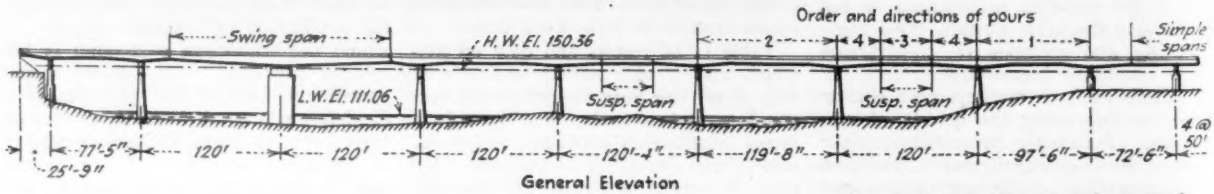


Fig. 3—General elevation and structural details of Fifth St. bridge, Augusta, Ga.

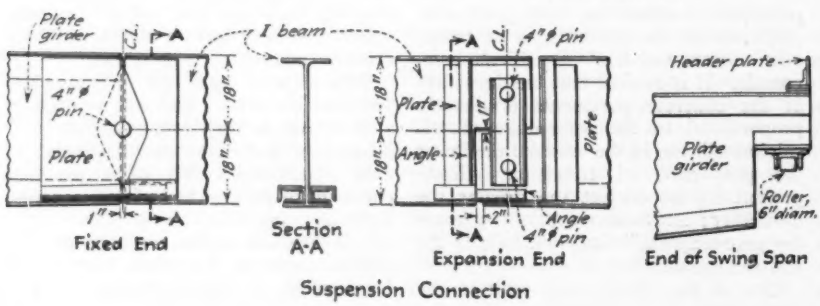


Fig. 3, was selected so as to produce as much stress in the girders over the piers and in the cantilever arms as possible before the concrete decks were placed on these sections. The roadway slabs were completed two spans ahead of the placing of concrete in the curbs and sidewalk slabs. In placing concrete deck on the swing span the work began at each end at the same time, and the

Fig. 4—Relief bridge of concrete deck girders that replaced 1,200 ft. of fill in approach to Fifth St. bridge, Augusta, Ga.

batches were deposited at the ends alternately so as to keep the span as nearly balanced as possible at all times. In the first one or two spans, allowance was made for computed deflections, but it was found that the actual deflection was somewhat less than the computed deflection, so adjustments had to be made. In adjusting the plate-girder swing span considerable difficulty was encountered due to change in temperature in different parts of the structure.

The main river bridge was built jointly by the state highway board of Georgia, the South Carolina state highway department, the city of Augusta and Richmond County, Ga. The relief bridge and approaches were built as a federal flood-relief project under the general supervision of the U. S. Bureau of Public Roads.

The contractor for the substructure and concrete deck on the main river bridge was Wannamaker & Wells, Orangeburg, S. C. The contractor for the steel superstructure was the Nashville Bridge Co., Nashville, Tenn. The relief bridge was built by Mallory & Nash, Atlanta, Ga. The field work was under the direct supervision of C. A. Marmelstein, resident engineer. Plans were prepared by the bridge department of the state highway board of Georgia.

Welded Alloy Bucket Lips Cut Trenching Costs

Worn bucket lips restored quickly and given longer life by welding on new cutting edges of a wear-resisting alloy

By George Sykes
Haynes Stellite Co., New York, N. Y.

COST DATA furnished by the contractors on trenching for a 28-mile water main constructed in Nebraska show considerably reduced trench-excavator costs due to the practice of welding wear-resisting alloy edges to worn bucket teeth. The ditcher teeth naturally receive the greatest wear of any individual part of a trencher, with the result that a full set of teeth must normally be sharpened every few days. This dressing cost is likely to mount to a considerable sum, particularly if the trench is being cut in sand or shale. By hard-facing the cutting edges of the teeth it is possible to increase the life of a set to five or even more times that usually obtained.

Some interesting results have been shown by figures being kept on a trenching job for laying 36-in. cast-iron water pipe from Lincoln to Ashland, Neb., a distance of 28 miles. This ditch is 5 ft. wide and from 6½ to 18 ft. deep. The trenching machines employed for this work, as shown in the accompanying illustration, are of the boom type, so that the digging teeth strike the earth in a horizontal position. Each set of cutters consists of 105 to 120 teeth, costing 60c. each. After the teeth become dull it is necessary to draw them out at a cost of 15c. per tooth, including removing and resetting. In other words, a full set of new teeth costs from $63 to $72, while the dressing and removal expense amounts to $15.75 to $18 per set.

Ladder-type trench excavator employed on 28-mile water main from Lincoln to Ashland, Neb.

When the job was first started, ordinary steel teeth were used in the machines. A close check on the life of the teeth disclosed that after 2,000 ft. of trench had been dug it was necessary to replace the entire set. A second set was installed and the same service life was obtained. Before the third set of teeth was inserted, they were given a protective surface of wear-resistant alloy of cobalt, chromium and tungsten on their cutting edges. These hard-faced teeth were examined after they had dug 28,000 ft. of trench, and it was found that only about one-third of the teeth required removal for rebuilding with more hard facing alloy. It was estimated that this set of teeth was capable of considerable more digging before replacement would become necessary.

The cost of hard-surfacing a set of teeth is but a few cents a tooth, a small fraction of the price of a new tooth. By applying this wear-resisting alloy, a saving of more than fourteen dressings, which would have had a total cost of approximately $250, was assured. After fourteen dressings of these teeth they would be completely worn out, making it necessary to spend an additional $63 or $72 for new teeth. In the case of hard-surfaced teeth it is calculated that they will last indefinitely. From this, the economies possible on a pipe line many miles in length can be readily visualized.

Either the oxy-acetylene or the electric-arc process may be used for hard-surfacing, only a few simple modifications of the usual welding procedure being required. With the oxy-acetylene process an excess acetylene flame is used, and the base metal is brought only to a sweating heat. The welding rod is then melted in the blowpipe flame and flowed over the surface of the metal to form a coating of the desired thickness. When the electric-arc process is used, the polarity is reversed.

The contractors in charge of laying this pipe line point out several factors of economy: The cost of replacement parts and labor is reduced to an absolute minimum; there are fewer shutdowns with resulting loss in time and yardage of trench excavated; and fuel consumption is reduced 10 to 15 per cent because sharp teeth run very easily, while a partly dull set becomes increasingly hard to pull.

The general contractors for the work, including wells, pumping stations and mains, were the Abel Construction Co. and the Dobson Construction Co., of Lincoln, Neb., who submitted a joint bid. Humphrey Bros. Construction Co., Lincoln, Neb., were subcontractors for the trenching.

Comprehensive Storm Sewer System for Dallas, Tex.

New system involves use of existing streams where possible—Experimental studies indicate that rains during summer months contribute little to runoff—Design based upon a storm of five-year frequency

INVOLVED in the new comprehensive storm-drainage system for Dallas, Tex., now under construction on three main watersheds, are special studies of rainfall and runoff, special investigations of the Trinity River stages as affected by the reclamation of the bottoms opposite the city and the reservoirs built and proposed above Dallas, investigations of constructing sewers by tunneling through the limestone or chalk, economies of design using various routes, different gradients and combinations of watersheds through diversions. Finally the effects of the decrease in estimated costs were determined as more definite conditions were learned regarding prices. Not all of these subjects can be covered fully in this article, and some of them are of local interest only. The rainfall and runoff research is unique. The basic design methods are of general interest, and the close tie-up between economies of the various designs and the changing financial status of the country is unusual.

Only in the business section and o one of the four main watersheds o which Dallas is situated have adequat provisions been made for the runoff o surface drainage. The Turtle Cree development, partly in Dallas and partl in Highland Park, is one of the fines examples of the preservation of a natural water course to serve as a municipal storm drain that can b found in the United States. The de velopment, landscaping and parking o this valley is unusual. The saving t the people and the avoidance of an ex pensive series of storm sewers far more than compensated for the value of the land segregated or for the cost of improvement or maintenance. Elsewhere in Dallas, with a few small and isolated exceptions, the water courses run through private property, the street plotting having been made without particular regard to the topography. In consequence the creeks are now found running across lots and in back alleys. They are badly obstructed and insanitary. This situation has long been recognized, and the importance of rectifying it has been the responsibility of local property-owners' associations in the residential areas. Money to the extent of $3,500,000 was set aside in a $20,000,000 omnibus bond-issue program voted in 1928. This was to pay the city's share of an $8,000,000 storm-sewer program, which was set forth only in a general way in the ordinance authorizing the bonds. An engineering survey and a report by a consulting engineer thoroughly versed in storm-sewer matters was to precede any expenditures. No such report was made, however, and a controversy arose between the residential section and the city and county of Dallas levee district, which was reclaiming a large area of

Fig. 2—One of the three large outlet storm sewers (Mill Creek) on the new system in Dallas, Tex. This view shows the arching section used under railroad tracks.

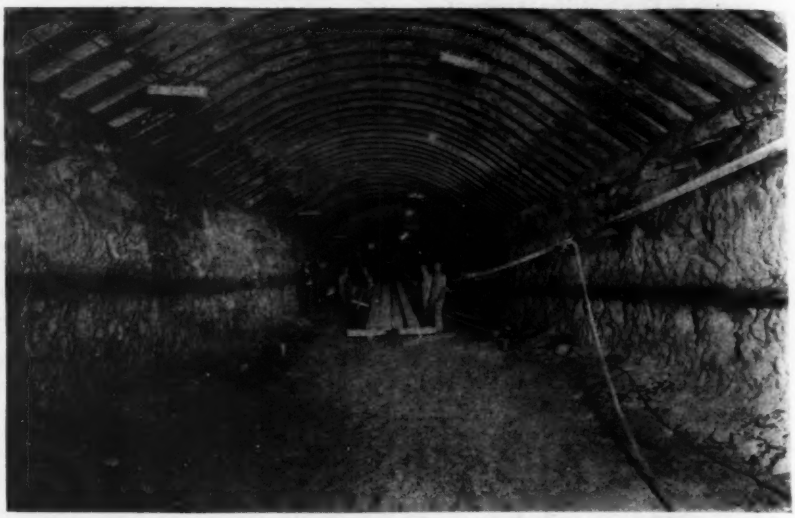
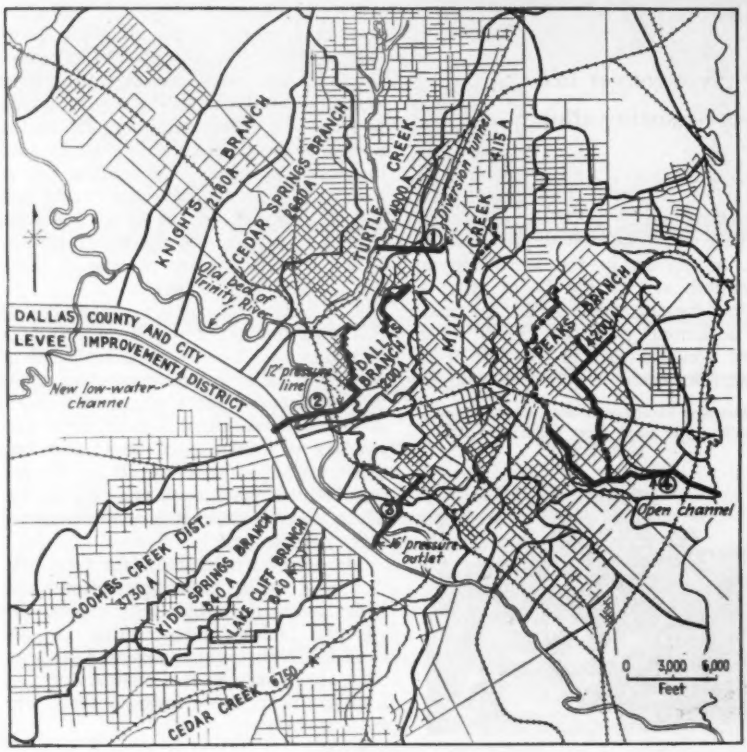


Fig. 1—Drainage districts covering major portion of Dallas now are served by new outlet storm sewers. The outlets for Dallas Branch and Mill Creek are pressure lines, and the one for Peaks Branch is mainly an open channel. Upper Mill Creek is diverted into the existing Turtle Creek system.



Trinity River bottoms adjacent to the business section. The levee officials claimed that it had a definite commitment for a large part of these funds to care for drainage required to complete the reclamation plan (*ENR*, Nov. 21, 1929, p. 804). This plan involved carrying the stormflow of certain sections of the city downstream from the city and the construction of sewers in the reclaimed areas.

Following one or two false starts, it became apparent in 1931 that the $8,000,000 system originally contemplated was impractical of financing, since it would require the issuance of special-assessment bonds. These the city had never issued for storm sewers. About $1,000,000 had been spent for small sewers ahead of paving and for isolated sections, but they had been built without any comprehensive plan. Soon after a change to the city manager form of government occurred in 1931 an intensive study of the situation was made, and in September, 1931, a report was presented which recommended allocating the remaining $2,500,000 to the improvement of three watersheds. This improvement would compromise the controversial difference between the levee district and residential associations. Lower prices for construction and close designing to take advantage of the most advantageous alternates of many studies indicated that the greater portion of the urgently needed work could be completed within the funds available on a monthly schedule of expenditures to finish early next summer.

By Nov. 1, 1932, contracts were in effect for $1,275,000 worth of work, some of the smaller projects had been completed and one large outlet, (Dallas Branch), involving an open-cut sewer in the levee bottoms and rock tunnel in the city, was nearing completion. Turtle Creek diversion tunnel was about to be put in service. Another large system (Upper East Peaks Branch) was two-thirds finished. Three other sections of Peaks Branch were under contract, and work on the third large outlet (Mill Creek) was well under way.

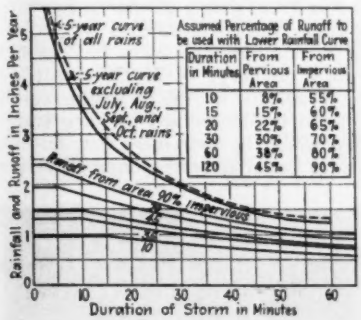

5-year curve of all rains
2-5-year curve excluding July, Aug., Sept., and Oct. rains
Runoff from area 90% impervious
50%
10%
Assumed Percentage of Runoff to be used with Lower Rainfall Curve
Duration in Minutes
From Pervious Area
From Impervious Area
10 8% 55%
15 15% 60%
20 22% 65%
30 30% 70%
60 38% 80%
120 45% 90%
Rainfall and Runoff in Inches Per Hour
Duration of Storm in Minutes

Fig. 3—Records of excessive rainfalls in Dallas for eighteen years yield five-year rainfall frequency curves and runoff curves for various percentages of impervious areas.

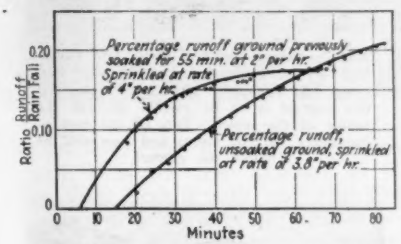

Percentage runoff ground previously soaked for 55 min. at 2" per hr. Sprinkled at rate of 4" per hr.
Percentage runoff, unsoaked ground, sprinkled at rate of 3.8" per hr.
Ratio Runoff / Rain fall
Minutes

Fig. 4—Runoffs from a test plot to which artificial rains were applied by sprinkling during summer.

Bases of Design — The following fundamentals of general planning for the system were adopted: Drainage can best be developed by preserving the natural water courses, enlarging them where necessary, protecting them from obstruction and carrying out such landscaping as may add to their natural beauty. Such a system can be carried out inexpensively only if it is planned when the land is plotted. If it is done later, the cost of removing obstructive and nonconforming conditions must be balanced aaginst the cost of closed storm sewers. If such an ideal drainage plan is to be successful permanently, the channel must be separated from adjacent private property by public strips of parks or marginal roadways. Where development is intensive, closed sewers are the only possible economic solution.

Closed vs. Open System — Of the several paralled watersheds discharging into the Trinity River in the closely built-up Dallas Branch valley only a closed system is practical. In the more open Mill Creek valley attractive open-storm drainage has been preserved through two parks. Elsewhere in this valley the original creek bed has been extraordinarily diminished in places, and sections of culverts carry the stream across streets and under some private property. Development of an open channel was considered possible but too expensive for all except isolated sections. On both of these streams most of the existing culverts, after clearing of obstructions, could be used as part of a closed system. The third watershed, Peaks Branch, is even less built up, and much more open channel is practical. In general, the lower half of this watershed is rather steep, while the upper portion is comparatively flat, making possible the diversion of the flow by tunnel to an adjoining watershed. Although the tunnel scheme was not adopted for this watershed, it was done in diverting the upper Mill Creek drainage into the Turtle Creek open-channel system, which reduced greatly the necessary capacity and cost of the lower Mill Creek outlet.

Further studies of comparative plans and estimates covering the outlets of Mill Creek and Peaks Branch showed that tunnels to divert the flow to the neighboring water course so as to give more direct outlet to the river would be slightly more expensive than standard cut-and-cover sewer construction following the lines of the existing water courses. There was some uncertainty in these results due to some doubt as to whether the comparative prices for tunneling and open-sewer construction were properly equalized. As it turned out, while both tunnel and open-cut construction were finally found to be cheaper than the original estimates, the large reductions have been in open-cut construction. In consequence, the results have been even more favorable to the simple scheme of outlets than the estimated comparisons indicated.

Runoff Research—Rainfall and runoff were studied in detail for Dallas conditions. No automatic rain-gage records earlier than 1913 are available but fortunately Fort Worth records go back to 1900 and were used as checks. Excessive rainfalls for eighteen years were listed and plotted. Those points which have been exceeded four times at each of the duration periods listed were joined, forming the five-year curve shown on Fig. 3, one that will probably be exceeded once in five years. Thus the storm sewers were deliberately designed for rainfall intensities below the maximum. This practice is considered justified when the damage from overcharge can better be afforded than the present cost of building according to a higher intensity curve. Dallas is especially suited to a low curve, as there are few basements.

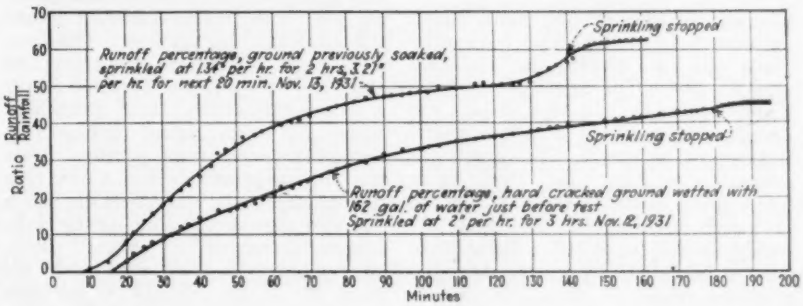

Runoff percentage, ground previously soaked, sprinkled at 1.34" per hr. for 2 hrs. 3.27" per hr. for next 20 min. Nov. 13, 1931
Sprinkling stopped
Sprinkling stopped
Runoff percentage, hard cracked ground wetted with 162 gal. of water just before test Sprinkled at 2" per hr. for 3 hrs. Nov. 12, 1931
Ratio Runoff / Rainfall
Minutes

Fig. 5—Sprinkling tests on Nov. 12 and 13, 1931, on an 18x18-ft. plot, hard, dry and cracked, but well grassed on Nov. 12 and wet on Nov. 13 from previous day's sprinkling. Both tests were carried much beyond the usual 60-min. period, and in the Nov. 13 test a 20-min. shower was placed at the end of a typical two-hour rain, a nearly impossible occurrence.

They are not connected and therefore are not subject to damage from backwater.

Experiments on runoff were carried out by Leland Chivvis at the civil engineering department of Southern Methodist University in cooperation with Prof. T. G. McCarthy. An irregular-shaped area of 357 sq.ft., having an adequate slope and a good stand of Bermuda grass on a typical local soil, was fenced off by driving 16-gage iron plates around its border. A 1½-in. drain pipe was led from the low end to a testing sump. A metered supply, simulating given rates of rainfall, was sprinkled onto the plot. The first test, on grass burned brown by five days of sun, was 2⅜-in.-per-hour rain, lasting two hours. It produced no runoff. The grass was noticeably greener, and there were soggy pools in the level spots, but the 5¼ in. of artificial rain had been absorbed as fast as it fell. Other tests made in July, 1931, on moistened ground produced runoff as shown in Fig. 4. Within an hour runoff never represented more than 20 per cent of the rainfall at 4-in.-per-hour rates, whereas similar tests elsewhere on clay soil and blue grass have produced 70 per cent runoff in the same period. An appreciable amount of lateral percolation under the plates was accounted for by the cracked texture of the soil in summer. This leakage was estimated as adding 6 in. to all dimensions of the plot, or 11 per cent. Evaporation was estimated at 5 per cent. These two factors increased the observed maximum of 20 per cent to a runoff of 23 per cent.

From the above data the following percentages of runoff from pervious surfaces under maximum summer conditions were adopted: For 10, 15, 20, 30, 60 and 120-min. durations, 5, 10, 15, 20, 25 and 30 per cent runoff, respectively. From experience in other cities the runoff from impervious surfaces was taken at 55, 60, 65, 70, 80 and 90 per cent for the same respective durations.

Even though the figures for runoff from pervious areas were based on tests made on ground that had previously absorbed 11 in. out of almost 12 in. applied in the preceding 45 hours, it was doubted that spring and fall conditions had been approximated. Evidence and opinions on the subject received from various sources all indicated that more severe runoff conditions are met with in the seasons of moist ground and minimum soil porosity. The summer runoff percentages from pervious areas were accordingly increased 50 per cent to approximate these conditions. Since the experiments indicated a negligible runoff from pervious areas that are comparatively dry, a new five-year rainfall curve was drawn up, which excluded the precipitation during July, August, September and October. Runoff computations were then made for areas 10, 35, 45, 70 and 90 per cent impervious and plotted as shown on Fig. 3. Checks made at an imperviousness of 35 per cent with the Fort Worth five-year curve showed small variations. Excluding the summer months, the Fort Worth and Dallas curves are almost identical.

Tests on Nov. 12 and 13 on a slightly smaller plot are shown in Fig. 5.

During the spring and summer of 1932 the runoff experiments were repeated under moist and consolidated soil conditions. Runoff rates were found to be greater than those found from the summer series of 1931, but in general they were slightly less than the percentages that had been adopted.

Five typical blocks in widely separated parts of the three watersheds under consideration were measured and plotted. Houses, sheds, garages, walks and other paved areas, including one-half of the surrounding streets, whether paved or not, were classified as impervious. Contrary to usual practice, alleys were classed as pervious, as this is their condition in Dallas.

Gradient vs. River Stages—A critical problem was that of determining future stages of the Trinity River during floods, since stages in turn determined the capacity of the outlet sewers. A 27-year record of gage heights was available. The highest recorded was 52.6 in 1908, with a discharge estimated at from 185,000 to 225,000 sec.-ft., and the second highest was in 1922 at 42.4, with a discharge of 75,000 sec.-ft. If the gradients of the drainage system were to be determined by such stages, they would be extremely flat, and the sewers would be correspondingly larger.

Fig. 6—Outlet of 8-ft. Mill Creek diversion tunnel into Turtle Creek open system.

Fig. 7—Laying invert of 16-ft. Mill Creek-Bellview horseshoe sewer in the levee bottoms. At this point a double rectangular box culvert is to be carried through the center of the sewer. Part of the area of the sewer will be above and part will be below the culvert.

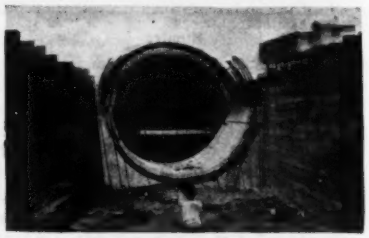


Fig. 8—Dallas Branch 7-ft. open-cut monolithic circular sewer.

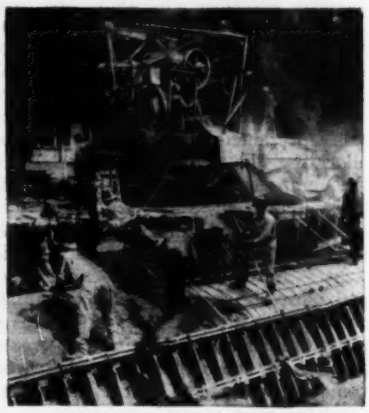


Fig. 9—Peaks Branch sewer in open cut close to surface was concreted with a paving mixer operating on the street.

This would mean a great expense to meet a need occurring only twice in 27 years. A reduced capacity simply means that the rainfall would not be carried off so promptly and would not be a serious matter like the overtopping of levees. On the other hand, ponding in the streets and possibly flooding of improved property while the most intense rain is falling may result in some property damage.

A 42-ft. stage has been exceeded on six days in 27 years; one of 41 ft. on ten days in 27 years; one of 39 ft. on 38 days in 22 years, and one of 35 ft. on 68 days in 27 years. Stage 39 ft. has been exceeded about 1½ days per year, and it seemed to merit serious consideration as the basis of design, especially if the record showed any great probability of a critical rain coming at the same time. But on only one of the three times in a period of fifteen years when the river reached 39 ft. had there been a rain, and that had been but ¾ in., too small to produce any great flow. Thus if this stage were to be used in determining gradients, it would involve extravagant and unnecessary construction. A 37-ft. stage could properly have been chosen, if it could be safely assumed that the river stages in the future would behave as they have in the past. But the channel improvements in the vicinity have had the effect of reducing the stage of the river by from 1 to 1½ ft. In other words, stage 36 of the future is equivalent to stage 37 of the past. There has been in recent years a series of reservoirs built and contemplated, which it was estimated would pull the stage down another foot, to 35. These considerations made practical a large saving over the former estimates of costs, which had been made on the basis of lifting the gradient to care for a 41-ft. stage.

Construction—The Dallas Branch outlet was designed as a circular reinforced-concrete section and was built in wet ground within the levee district. Compared with a horseshoe section, the circular type of sewer requires a heavy wall section unless positive horizontal pressure can be definitely assured. When sheetpiling is used and pulled or where outside forms are used and removed the development of this pressure requires a long time, and heavy vertical loads may occur before the relieving forces are effective. This matter is much simpler in the case of horseshoe sewers with sloping sides. Again, the construction of the inverts of circular sewers requires an invert form that must be held down against the upward pressure of the concrete. There is required an elaborate additional jacking system that interferes seriously with the freedom of operation in the trench. These factors do not exist with the flat inverts of the horseshoe type. Because of these disadvantages of the circular section as compared with a horseshoe type, the latter was adapted for the Mill Creek-Bellview outlet under similar wet condition, thus reducing the cost and making a simpler construction job.

In the open-cut portion of the Mill Creek 16-ft. horsehoe sewer, after the invert has been placed, the concrete in walls and arch is placed in 49-ft. sections, using 50-ft. steel forms. Each section calls for 9 tons of reinforcing steel and 78 cu.yd. of concrete. Steel is set in advance in four hours at a cost of $3.25 per ton. In another four hours the contractor moves the track, releases the forms, advances them and sets up ready for deposition of concrete. One man, the concrete puddler, checks the steel clearance in the time between the final jacking of the forms and the time of starting to concrete. The 49-ft. section is deposited in six hours. By advancing the forms within the steel cage the contractor gains four hours of time per section. It is as easy, he claims, to do this as to erect the forms in the open, the puddler's time checking clearances being negligible. The forms come apart in five sections, four men doing the work in four hours.

When this section was built in rock tunnel the advance was 16 ft. per day of two shifts, with four 90-lb. shots of dynamite in each shift. An automatic loader was used. In finishing the interior surface, holes are filled with plaster as soon as possible, and after the concrete has set all rough spots, particularly at joints, are chipped. The interior surface of the tunnel is then brushed with a grout coat and rubbed down with carborundum. On the Mill Creek tunnel, where the forms are smooth, there has been little need for finishing the entire surface, and only the rough spots and the joints have been rubbed.

To meet the topographic and geological conditions, all tunnel construction is in the "white rock" or chalk, far below the hydraulic grades. Due to the unusually satisfactory tunneling in the soft rock some of the tunnels have been driven so close to specifications that the concrete will not exceed the minimum section by more than 10 per cent as compared to the not unusual figures of 40 to 60 per cent in the harder ledged limestone of the Middle West.

Fig. 10—Three views of the 16-ft. Mill Creek horseshoe open-cut section. View at left shows how steel was placed ahead of forms, saving about four hours in each 49-ft. section. In the center view steel chairs and spacers are being placed by the puddler after the forms have been jacked into place. At right is shown the pouring and finishing operation.

Concrete lining in these tunnels placed by air shows an unusually smooth finish that will give a coefficient of roughness of $n = 0.012$, or 0.011 in Kutters formula. This means that the finished sewers will be good for a record rain of greater frequency than is expected—that is, while the sewers were designed on a basis of a rainfall curve having a five-year frequency, they will now be good for a seven- or eight-year frequency.

Personnel—The Dallas storm sewer work is being supervised by W. W. Horner as consulting engineer while on special leave from his position as chief engineer of paving and sewers of the St. Louis board of public service. Leland Chivvis is resident engineer for Mr. Horner, working with C. J. Baer, storm sewer engineer of the Dallas public works department, of which O. H. Koch is director and F. N. Baldwin executive engineer. Tim Conroy is engineer of construction for the city on the work.

In the study of probable stages of the Trinity River a special investigation and report was made by S. W. Freese, of Hawley, Freese & Nichols, consulting engineers, Fort Worth. The work in or affecting the levee district was approved by Myers, Noyes & Forrest, engineers for the levee district. All work is being carried out under the general supervision of John N. Edy, city manager.

X-Raying Welded Steel Plates up to 4-In. Thickness

New X-ray equipment capable of continuous operation at 300,000 volts makes examination of thick welded steel plates practicable—Similar apparatus necessary for examining penstock pipes at Hoover Dam

By R. E. Hiller
Babcock & Wilcox Co., Barberton, Ohio

THE FOLLOWING article, abstracted from the *General Electric Review*, is of particular interest and timeliness in view of the fact that the company with which the author is associated has the contract for fabricating and erecting the penstock pipes at Hoover Dam. On this work several thousand feet of steel-plate pipe, from 13 to 30 ft. in diameter and with shell thicknesses from 1⅜ to 2⅞ in., are to be fabricated by arc-welding, and the specifications require that the entire length of each welded joint be subjected to X-ray examination. The X-ray work described in the following article (examining welds of 4½-in. plates for mercury boiler drums) has been done with a new high-voltage tube and apparatus that may find application at Hoover Dam. Similar apparatus also proved its efficiency in checking the welding of even thicker plates used for the water wheels of the Dnieprostroy power plant, which were built by the General Electric Co. —EDITOR.

THE APPLICATION of fusion welding to continually increasing thicknesses of steel has made it necessary to find means of examining these welds for quality, and the X-ray method has been found very useful. However, until very recently industrial X-ray tubes were not available for operation at voltages higher than 200,000, which prevented direct examination of steel sections thicker than 2¼ in. Greater thicknesses than this necessitated operating a 200,000-volt tube above its rated capacity, with a resultant decrease in the life of the tube.

The recent development by the General Electric X-Ray Corp. of a fine-focus X-ray tube and high-voltage outfit capable of continuous operation at 300,000 volts has materially increased the thickness of steel that can satisfactorily be penetrated. One of these tubes with the necessary power equipment has been installed at the Barberton, Ohio, works of the Babcock & Wilcox Co., and has been used for production examination of more than 350 ft. of welded seams in mercury boiler drums constructed of plate 4½ in. thick.

The new X-ray tube (Fig. 3) is 4 ft. long with a bulb 8 in. in diameter, and is constructed of pyrex glass ¼ in. thick as compared to ⅛ in. for the old-type 200,000-volt tube. The diameter of the bulb is the same as that of the usual 200,000-volt tube, but the cathode and anode arms of the new tube are longer. The target is a tungsten disk held in a copper block. The entire block is water-cooled. The cooling unit is a closed system with a motor-driven pump that maintains a line pressure of 50 lb. per sq.in. and a radiator in which a thermostat is so connected as to operate a circuit breaker in case the cooling water becomes too warm. The tube is rated for operation at 300,000 volts and 10 milliamperes.

EXPOSURE TABLE USING 300,000 VOLTS AND 10 MILLIAMPERES AT 30-IN. FOCAL DISTANCE

Thickness of Steel, Inches	Time
2½	10 sec.
2¾	20 sec.
3	40 sec.
3¼	2 min.
3½	4 min.
3¾	9 min.
4	15 min.
4¼	30 min.
4½	50 min.

The power unit of the installed apparatus consists of a Kenotron tube arrangement connected in a voltage "doubling circuit." Power supply for all equipment is 220-volt, 60-cycle single-phase current. When operating at full load, between 25 and 30 amp. in the power line is used.

This increase to 300,000 volts for continuous operation of X-ray tubes makes it possible to carry out very rapidly the X-ray examination of thick steel sections. The exposure times required for various thicknesses of plate are shown in the accompanying table.

The general arrangement of apparatus, as installed at the Babcock & Wilcox Co., is shown in Figs. 1 and 2. The equipment room is 10x16x10 ft., the control booth 4x4½ ft., and the tube box 9 ft. by 44 by 48 in. For protection from X-radiation the tube box is lined with ⅛-in. lead, and the control box is additionally protected by ⅛-in. lead. The only opening for X-ray is an aluminum window 5x5x⅛ in. thick, in front of which is placed the welded vessel to be examined. The particular vessel shown in Fig. 1 is a mercury boiler drum with a 4½-in. wall thickness, 26 ft. long and 30 in. inside diameter.

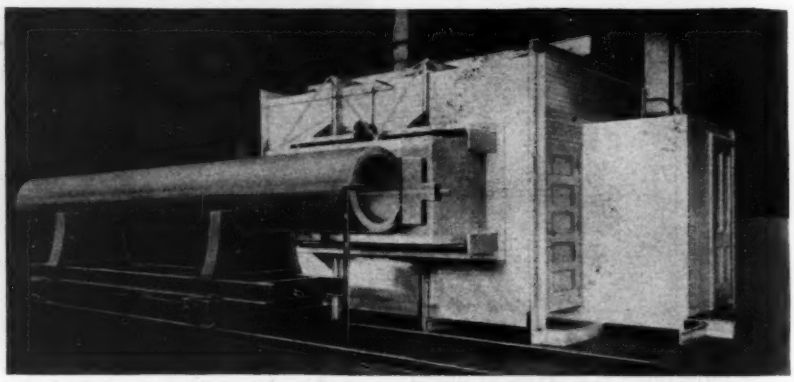


Fig. 1—Welded pipe or boiler drum is slowly moved past the X-ray tube, which is installed in a lead-lined box.

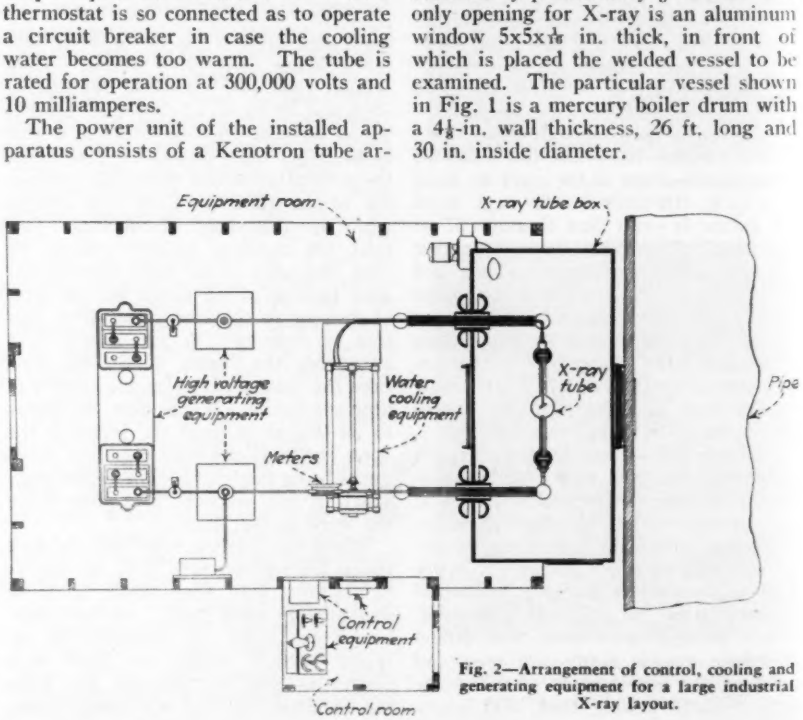


Fig. 2—Arrangement of control, cooling and generating equipment for a large industrial X-ray layout.

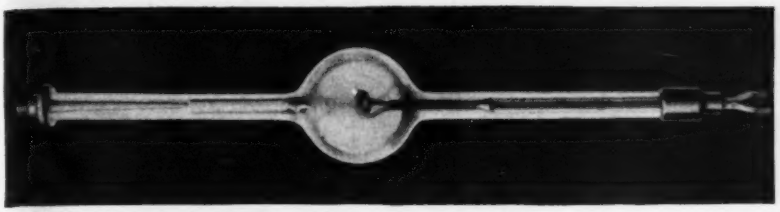


Fig. 3—New 300,000-volt tube whose X-rays can penetrate 4 in. of steel plate.

For the actual X-ray examination of welds in the mercury boiler drum these welded seams were marked off in 10-in. sections, and each section indicated by lead numbers was placed along the weld on the outside surface. The inside surface of the weld was marked off in corresponding 10-in. lengths in order that the film might be properly placed for each exposure. As each exposure of a 10-in. section was completed, the drum was moved along the tracks so as to place the next section in front of the window of the tube box. Approximately 2 ft. of weld was examined per hour.

Open-Truss Bar Joists Simplify Wall Construction

By J. I. Bennett
Construction Engineer, Huron Milling Co., Harbor Beach, Mich.

THE TASK of refacing with concrete a dock wall of the old stone-filled wood-crib type presented some peculiar formwork difficulties, which appear to have been successfully solved recently in rebuilding a dock for the Huron Milling Co. at Harbor Beach, Mich. The dock or pier had crib walls on three sides and was 230x170 in plan.

A gravity-type wall, on account of the excessive concrete and hand-excavating involved, was deemed impracticable to use, as was also the reinforced L type. The uncertain condition of the timber cribbing and its doubtful capacity to withstand the added weight of materials in a facing wall of great bulk were other factors leading up to the selection of the anchored or buttressed type shown in the accompanying drawing.

In order to bond the back of the wall with the closely packed stone filling, it was decided to dispense with the inside form and pour the concrete directly up to the stone. In doing this the problem presented itself of holding the single outside form in position and of preventing its yielding laterally to the pressure of the wet concrete.

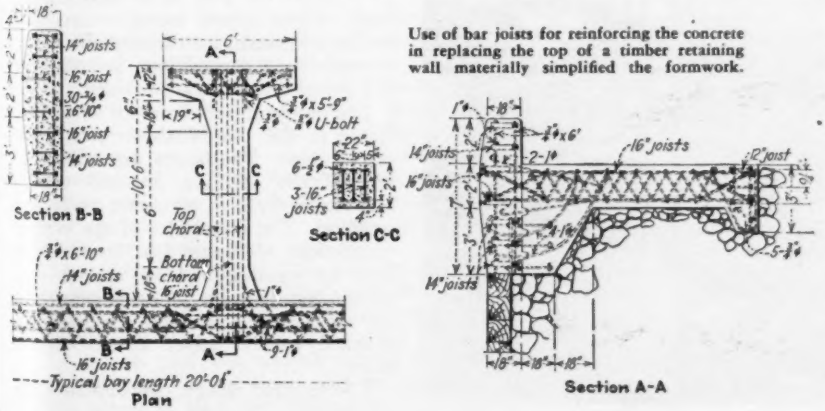
To overcome this difficulty and to make the construction procedure more elastic, it was decided to build in advance reinforced-concrete deadmen about 20 ft. c. to c. The purpose of the deadmen was to furnish strong connecting points for the wall forms and at the same time provide the buttress and anchor features deemed necessary for a wall of this type.

The front end of these deadmen was provided with anchor bolts and channel washers, to which were bolted a horizontal series of heavy unpainted open-truss bar joists. To the outer chords of these joists were wired the vertical ribs of the outside wood form. The pull of the form wires against the stiff bar joists was transmitted directly to the deadmen, resulting in a firmly braced formwork system.

The dual function of the joists, providing first the backbone of the formwork and lastly the tensile reinforcement of the wall, resulted in marked economy throughout the progress of the work. A very noticeable feature of the open-truss joists as reinforcement was the ease with which they could be handled and placed.

Deformed rib bars were used to provide additional anchorage, vertical reinforcement, and also to furnish continuous action along the outer faces of the joist chords.

While the weight of the concrete wall facing is obviously intended to be supported by the timber cribbing, the cantilever effect of the embedded buttress with its double reinforcement cannot be overlooked and should prove to be a valuable feature in case the timber work ever required repair or replacement.



Use of bar joists for reinforcing the concrete in replacing the top of a timber retaining wall materially simplified the formwork.

Geodetic Leveling Marks in Oregon

A special publication, "Leveling in Oregon," has been published by the Coast and Geodetic Survey of the Commerce Department. It contains information of value to surveyors and engineers interested in irrigation, drainage, transportation, utility projects and allied development in that state.

This book (247 pp. and four illustrations) furnishes the descriptions and elevations of more than 2,800 benchmarks in Oregon, the results of geodetic leveling executed by the federal government and other organizations. Many of the valuable data were secured through the cooperation of the Oregon geographic board and the Oregon state highway department.

The standard benchmark disks now used by the Coast and Geodetic Survey are set in existing structures, in concrete posts cast in place for this special purpose and in available outcrops of rock. The book also covers benchmark disks used by the U. S. Geological Survey, Corps of Engineers of the United States Army, U. S. Bureau of Public Roads, U. S. Forest Service, U. S. Bureau of Reclamation, U. S. General Land Office, the Oregon state highway department, Oregon state engineer, the Clackamas County highway department, city of Portland, Pacific Power & Light Co., and the Portland Electric Power Co.

Captain Patton, director of the survey, stated that a benchmark is useful only as long as it is recoverable. When changes occur in surrounding natural and cultural features with relation to which the mark is described, as they often can and do, engineers and others who visit marks will render a public service by reporting the condition of the marks and any needed descriptive changes.

Mimeograph supplements, covering revised descriptions of benchmarks will be issued at intervals to persons and organizations using copies of this special publication and may be obtained from the director of the U. S. Coast and Geodetic Survey, Washington, D. C.

Hospital Addition Introduces Welding in San Francisco

Field welding permitted by building department on University of California structure for all lateral and earthquake stresses, with direct vertical loads taken by shop-riveted connections—Field-erection bolts required to be machined for a driving fit

By Edward M. Knapik
Structural Engineer, Associated With Walter L. Huber, San Francisco, Calif.

WELDED connections were used for the first time on a steel-frame building in San Francisco in the erection of the eight-story Medical School Building, University of California, which adjoins the University Hospital. Although not legally subject to city ordinance, the permission of the San Francisco building department was secured for the use of welded connections for all but direct loads; the present building ordinance has no provision for this type of construction. Connections for all lateral loads, including seismic forces, were arc welded, and direct loads were carried on shop-riveted connections. The building has a 293-ft. frontage with a depth varying from 44 to 99 ft. and contains 800 tons of structural steel.

The new building of the University Medical College, which is located in San Francisco, adjoins the occupied University Hospital, making the reduction of construction noises an important feature in design and erection. In addition to the use of field welding for the frame, pre-mixed concrete was specified, and the contractor was required to establish his field equipment as far as possible from the hospital. Loaded trucks were required to approach the site from a downhill direction as a further precaution in elimination of unnecessary noise.

The building ordinance of the city of San Francisco does not cover welded construction, and to date, except for light mill buildings, the rulings of the building department have not permitted dead and live floor and roof loads to be supported by welded connections. Although the building operations of the state university are not subjected to inspection by the city department, nevertheless care is exercised in conforming to city ordinances.

Fig. 1—First welded building frame in San Francisco goes up adjacent to hospital where quiet construction was desirable.

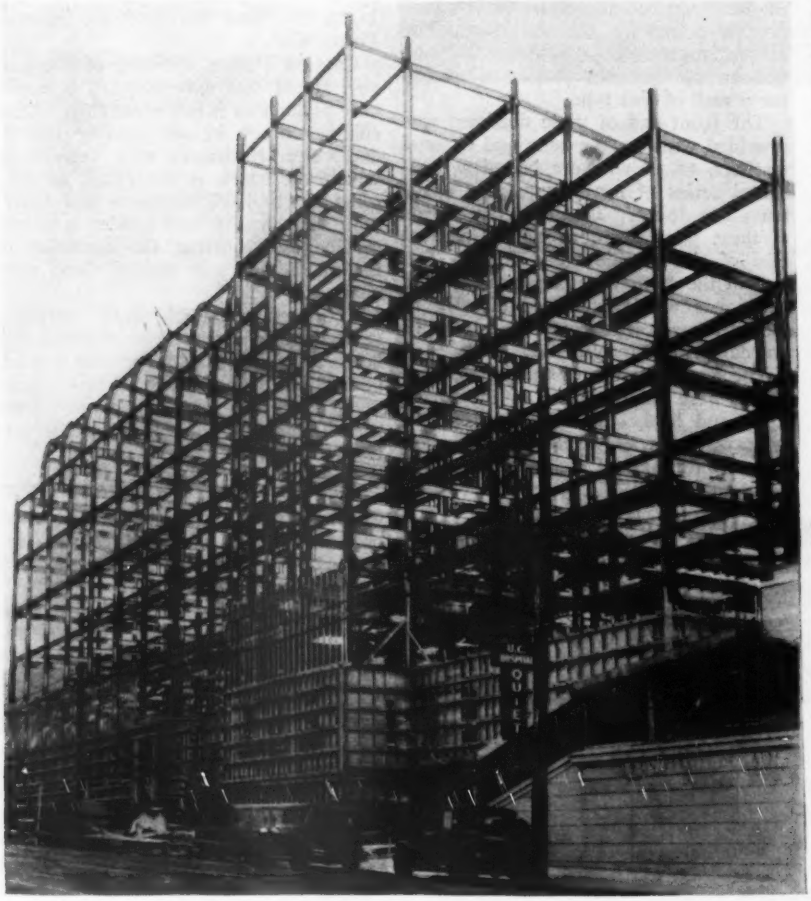
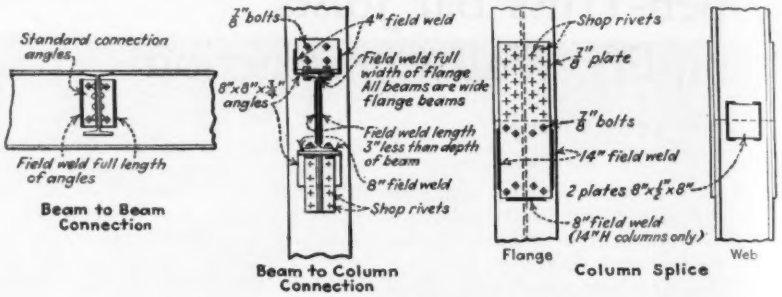


Fig. 2—Details of typical connections, showing use of shop rivets, machined field bolts and field welding.



Approval was obtained for a design that provided for transmitting all direct loads through shop-riveted seat connections, using field welding to secure members to these connections and to obtain necessary lateral bracing. The design provides for the resistance of a seismic force as well as a permanent lateral earth pressure resulting from the topography of the site. The ground surface slopes up from the street, making the inside line of the building about 25 ft. above the level of the first framed floor. These lateral forces are resisted by the component members of the frame through their connections, and no special portal bracing was provided.

The design differs from an all-welded frame in the use of shop-riveted seat connections. The beams are welded to the columns and are attached to the seat angles by both machined bolts and welding. The top angles of the typical connections are secured to the columns both by welding and by special machined bolts capable of developing tensile stresses and, in turn, are similarly fastened to the upper flange of the beam.

The original design contemplated the

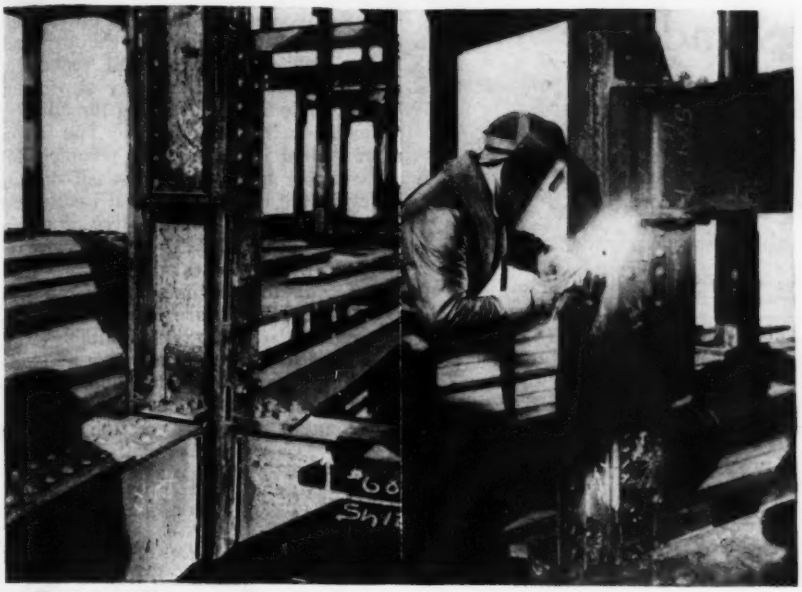


Fig. 3—Typical column splice and beam-to-column connections. Field-erection bolts are machined for a driving fit.

connection of beam webs to columns by welding plates on either side of the webs and onto the column shaft. At the suggestion of the contractor for fabrication and erection, these plates were omitted, the beams were milled to give a clearance not exceeding $\frac{1}{8}$ in., and the webs were welded directly to the columns. This procedure eliminated two lines of welding and speeded field erection. Where clearances exceeded the $\frac{1}{8}$-in. allowance, the plates, as originally proposed, were required.

All column splices were designed to meet the conditions for field welding. In addition to splice plates, filler plates were generally shop-riveted to the upper sections of columns, particularly where changes in sections occur. The splice plates were welded and bolted directly to the lower column section, the weld being designed to develop the full tensile strength of the plate. Welded web splice plates were added on both sides of the column. Where bearing plates were necessary between column sections, they were welded directly to the columns (Fig. 3).

All columns were connected by steel girders spanning 16 to 18 ft., and panels between columns were subdivided by reinforced-concrete beams giving concrete floor slabs of moderate span. Where intermediate steel beams were necessary, as around stair wells and elevator shafts, they were secured by means of two standard connection angles shop-riveted to the beams, with their outstanding legs field-welded to the supporting beam. This introduced a desired flexibility in the connection and eliminated a condition of continuity that would have resulted if the webs of the beams had been welded directly to the girders. Bolts were used to hold the beams in place for welding.

At the first, second and third floors angle kneebraces were provided between all spandrel beams and wall columns. Braces were secured by field welding directly to the beams and columns. The connection of spandrel beams to the channel side of columns using shop-riveted angles is shown in Fig. 4; beams parallel to the column flanges were welded directly.

All welds were $\frac{1}{4}$-in. fillet welds, and 150,000 lin.in. was required, including

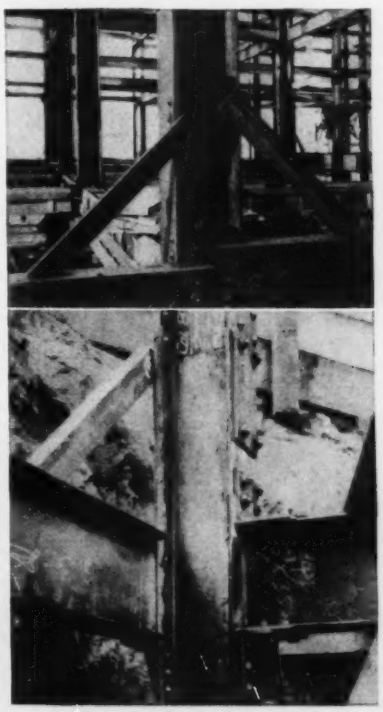


Fig. 4—Welded kneebracing between spandrel beams and wall columns. On the channel side of the column shop-riveted angles were required (top), and on the flange side the bracing was welded directly (bottom).

5,000 in. of shop welds. Welders were required to pass qualification tests; their experience ranged from six to seventeen years, and all of them had had previous field work on the U. S. Navy airship dock at Sunnyvale. All connections were designed to eliminate overhead welding, and butt-tension welds were omitted so far as possible.

The working stress assumed for the $\frac{1}{4}$-in. fillet welds was 3,000 lb. per lin.in. Connection and seat angles were burned to size, and surfaces to be welded were ground to remove burned material. Plates were straightened, and the edges to be welded were planed to an even surface. Any warped surfaces were straightened or ground to give even bearing, and all rust was removed in the shop. These preparations not only facilitated field erection but insured welds of maximum efficiency.

All permanent field bolts were $\frac{7}{8}$ in., machined to afford practically a driving fit, and the nuts were pulled up with a 3-ft. wrench before any welding was done. Bolt holes were sub-punched $\frac{3}{4}$ in. in the shop and reamed to $\frac{7}{8}$ in. in the field. After a joint was welded all bolts were tested by the field inspector to detect looseness. The use of machined bolts resulted in an increased factor of safety and assured a stiffer connection than would have obtained with welding and ordinary erection bolts. Shop rivets were $\frac{7}{8}$ in., and the low working stress of 10,000 lb. per sq.in., which was used for both bolts and rivets, further insured a uniform distribution of stress in the joint.

A section of exterior wall 56 ft. long and four stories high, together with four floors and roof, overhangs the first line of interior columns 8 ft. 7 in. where the building frames on the line of and above a portion of the existing hospital. This portion of the building is supported on two shop-riveted plate and angle cantilever girders at the second floor and frames entirely free of the existing building. Field connections on this section were welded and bolted in the typical manner.

Rolled steel slabs for the columns were set Oct. 25, and the frame was erected and completely welded by Dec. 14, 1932. The average output was 600 in. per day per welder. Ten welders and a foreman were employed on the work.

Engineers and contractors

The building was designed by William C. Hays, architect. Walter L. Huber was structural engineer, with the writer in direct charge of design and inspection of shop fabrication. Lindgren and Swinerton Co., San Francisco, was general contractor; the Judson-Pacific Co. held the subcontract for fabrication and erection of steelwork and contracted the field welding to Brown Bros. Welding Co. Inspection of the erection, field welding and bolting was handled by the Robert W. Hunt Co.

Shell of Concrete Standpipe Pre-Stressed by Steel Hoops

Walls under compression when 1.5-m.g. Minneapolis tank is empty—In construction steel bands were stressed by drawing up on turnbuckles—Architectural treatment involves use of molded concrete figures

By J. A. Jensen
Engineer of Waterworks, Minneapolis, Minn.

A WATER TOWER of reinforced concrete with a capacity of 1.5 million gallons, recently constructed in Minneapolis, Minn., was designed on the Hewett system, which involves pre-stressing the concrete by means of circumferential steel. The tank is situated on a hill in Washburn Park, a fine residential district located in a remote portion of the distribution area. Before the tank was constructed a serious problem was presented in the maintenance of pressure during hours of maximum demand, especially in the summer months. A standpipe in the district, of limited capacity and insufficient height, had become inoperative since the completion of the Fridley plant, which supplies water to this area by direct pumping, and for the past six years Washburn Park has been served by direct repumping with varying effectiveness. The water was taken from a near-by supply main that was already overworked, producing an aggravated situation that could only be relieved by suitable storage.

The district embraces a population of 5,000, and the water demand reaches a peak of about 900,000 gal. daily at the present time. It was decided to construct a reservoir with a capacity of 1.5 m.g. to allow for future population on the now vacant property and also for some possible enlargement of the service district.

Fig. 1—Figures of molded concrete are used for ornamentation on reinforced-concrete water tower in Minneapolis.

By allowing the tower to fill at night through check valves from the surrounding district, practically all repumping is eliminated. This feature also makes it possible to avoid robbing the adjacent mains during peak hours. The saving of $4,000 in the annual pumping bill makes the new tower almost self-sustaining in the matter of capital investment, aside from the prime object of giving the residents the kind of service to which they are entitled.

Owing to the character of the residences in Washburn Park, it was demanded that the tower be suitably ornamented so that its appearance might be an asset to the vicinity, and architectural features were developed to offset the usual plainness of the concrete

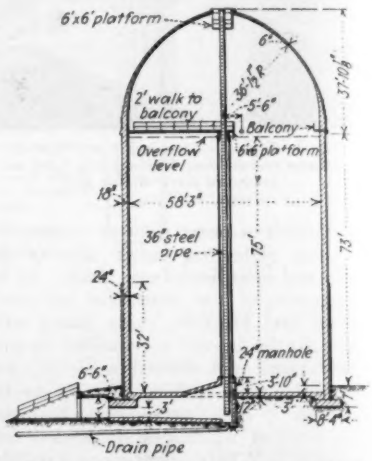


Fig. 2—Access to water tower is provided by a tunnel which terminates at the bottom of a 36-in. steel pipe running up to above the water surface. An interior balcony is provided at the top of the wall.

cylinder. This was done by widening the base section, by introducing broad pilasters and by covering the structure with a dome. To break the monotony of the broad faces of the pilasters, figures were molded of concrete and set at an intermediate height. To give the appearance of a crown at the spring line of the dome, figures of spread eagles were molded and set at the top of the pilasters. Back of these there are tapered ribs running to the top of the dome and terminating at a louvered cupola surmounted by a beacon light for aviators. The figures are molded with sharp lines, which together with the panel effect set the structure off with bold shadows and give it a striking appearance.

The structure has an internal diameter of 58¼ ft., and the height from the floor to the base of the beacon light is 118¼ ft. The depth of water to the overflow level is 75 ft. The wall rests on a circular foundation ring, 8 ft. 4 in. wide and 24 in. thick. The floor is 24 in. thick at the walls but reduces to 12 in. just inside the foundation ring.

The design of the standpipe is in accordance with the Hewett system. The

vertical wall is built in three layers. The innermost layer was poured first. It is 18 in. thick and contains two rows of vertical rods 10½ in. apart circumferentially. At the bottom these rods are hooked, and at the top of the wall they are threaded. At intermediate points splices are made by turnbuckles incased in a pipe sleeve. Before being set in place the rods were dipped in asphalt. After the wall was completed, bearing plates were placed at the top to receive the thrusts from nuts placed on the ends of the vertical rods. By means of these nuts all vertical rods were stressed to 18,000 lb. per sq.in. The asphalt coating permitted the tension to be carried down to the bottom hooks.

Circumferential bands of round rods were then placed around the outside of this cylindrical shell, increasing in spacing from the bottom up. Splices were made by means of turnbuckles, five to each hoop. The turnbuckles were taken up by special wrenches so that by predetermined pressure each hoop was drawn up to give the steel an initial tension of 16,000 lb. per sq.in.

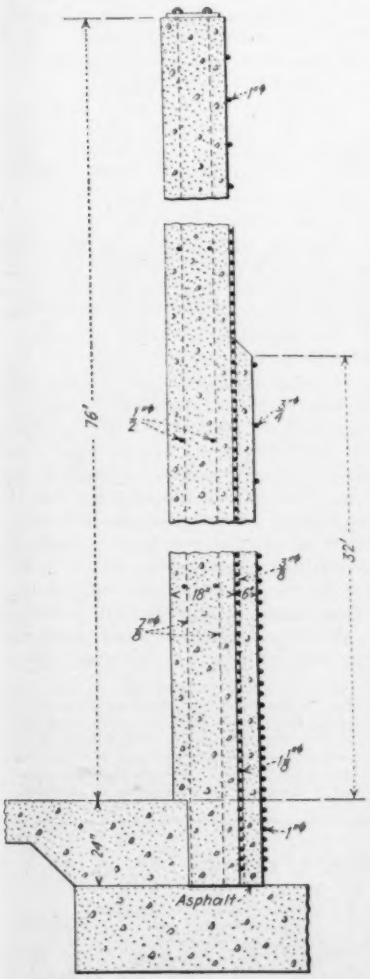


Fig. 3—Vertical walls consist of three superimposed cylindrical shells, the innermost shell (18 in. thick) being the main structural element of the wall. It is reinforced with vertical steel rods and is surrounded by circumferential steel hoops, all tightened by turnbuckles to pre-stress the concrete. The intermediate shell extends for only part of the height and is also pre-stressed by steel hoops. The outermost shell is used for architectural treatment and is not shown in this drawing.

The second layer or shell of the wall has a thickness of 6 in. and rises only to a height of 34 ft. above the foundation. This shell is also provided with hoops of round rods to provide sufficient steel to resist the greater water pressure at the lower portion of the tank. The hoops are likewise drawn up to the same initial tension as the inner set. By this means the concrete is subjected to initial compression, designed to oppose the full head of water. Theoretically the concrete remains under no stress when full water load is applied, or is possibly under some compression, and is therefore unable to stretch or crack under ordinary conditions in the transmission of stresses to the reinforcing steel.

The third shell of concrete was applied to cover the steel rods and to provide for the ornamental effects such as the widened base, the pilasters and the decorative details.

The dome springs from the top of the vertical wall with a radius of 36 ft. 1½ in., the centers tracing a circle 11 ft. in diameter. The dome consequently is prolate and higher than the tank diameter by about 5½ ft.

The forms for the inner shells were made of wooden pickets, raised for the successive pours. A considerable amount of staging was required both on the exterior and interior and for the support of the dome forms. The exterior form was made up of hard-faced wall board in order to secure as smooth a face as possible. All surfaces were rubbed down with corborundum stone by hand. The concrete aggregates consisted of crushed trap rock and washed sand. Compression tests of 28-day concrete showed strengths up to 4,500 lb. per sq.in.

The molds for the ornamental figures were of reinforced plaster of paris. The figures were cast from the same aggregates as those of the main structure except that a somewhat finer run of rock was used. The casts were made in sections weighing from 1¼ to 1¾ tons each. Eyebolts were set in the tops of each section to facilitate hoisting and setting and were burned off afterward.

Access to the upper portion of the tower is afforded through a tunnel from the face of the hill into the center of the tank. From this point a 36-in. steel pipe runs up vertically 76 ft. to a bridge that connects with a circular balcony on the inside. An open ladder continues vertically to the cupola to provide access to the beacon. The tunnel also serves to house gage instruments, floats and electrical apparatus controlling the beacon and auxiliary pumps. The riser pipe is provided with a steel ladder and also serves as the outlet for emergency overflow. A manhole plate at the base of the riser pipe makes it possible to enter the tank at the floor line when it is empty.

Personnel

The tower was constructed by the Minneapolis water department under the supervision of C. C. Wilbur, assistant engineer. It was designed by W. D. Hewett, structural engineer. The architectural features were designed by Harry W. Jones, architect, assisted by J. K. Daniels, sculptor.

Ancient American System for Collecting Water Supply

By J. B. Hamilton
National Park Service.

POSSIBLY the oldest water-collecting system in the United States which is still intact is a groove cut in the face of a cliff near Pueblo Bonito, Chaco Canyon National Monument. The near-by ruins are 1,000 years old, according to dates established by tree rings.

The groove is about 2 in. wide, 1 in. deep and 8 ft. long. In cross-section

Indian water-collecting system, 1,000 years old, catches runoff from cliff.

the rock chipped out in constructing it would represent a triangle 2½ in. by 4 to 6 in. A remarkable feature is the fact that the lip of the channel is not nicked along its entire length. Extremely careful work was required to accomplish this job with stone tools.

The cliffs behind the ruins are nearly everywhere vertical or overhanging, but the site for this collecting channel is in a position where the rock, although steep, would catch considerable runoff. A recess, apparently natural, below the end of the groove could have been used to hold a vessel to catch the discharge.

Rio Grande Rectification Will Control Floods

International Boundary Commission proposes a detention dam above El Paso and extensive channel rectification below El Paso to control destructive floods in El Paso-Juarez Valley

A POSITIVE step in solving the difficult problem of flood control in the stretch of the Rio Grande extending from El Paso, Tex., 155 miles to Box Canyon below Fort Quitman, Tex., has been taken by the signing on Feb. 1 by representatives of Mexico and the United States of a convention based on a report of the International Boundary Commission created by the two nations. The essential features of the flood-control plan taken from the commission report are outlined in the following article.

The situation calling for international action is made clear by a brief statement of the river and land development conditions in the stretches of river affected by the plan. The Rio Grande, rising in Colorado, flows almost directly south through New Mexico to El Paso, Tex., with Juarez, Mexico, across the river. At El Paso the river swings eastward and thence marks the boundary between Mexico and the United States.

Above El Paso the river valley lands are developed for irrigation, water being taken by means of diversion dams at several points along the river. In 1916 the Elephant Butte Dam was built about 150 miles above El Paso to store floodwaters for regulating the dry-weather flow for irrigation. Below El Paso the river valley, which is wider than it is above El Paso, is developed for irrigation on both the Mexican and the American sides. It is in this section that the great problem of flood control and land drainage has arisen.

Through the El Paso-Juarez Valley the river has a serpentine course, as shown by Fig. 1. The absence, since the completion of Elephant Butte Dam, of large scouring floods has changed the characteristics of the river channel through the valley. Floods from the runoff area lying between Elephant Butte and El Paso-Juarez are of annual occurrence. These would pass harmlessly through the valley were it not for the elevated bed.

The Mexican Department of Communications and Public Works and the city and country of El Paso have expended in the last few years more than $750,000 to protect the city of El Paso-Juarez and the valley lands from floods. These works consist largely of levees built along the banks of the meandering channel, and they require constant strengthening and repair on account of the raising of the riverbed. A more substantial and effective plan must be adopted to secure permanent and efficient protection.

General plan

The plan of Rio Grande flood control proposed by the International Boundary Commission consists of a detention dam at Caballo on the upper river above El Paso-Juarez and a rectified channel for 155 miles of the river below those cities. Briefly, the engineering features involve: (1) the reduction of river length in the El Paso-Juarez Valley from 155 to 88 miles; (2) the provision between levees along this 88 miles of a floodway 590 ft. wide having a capacity of 11,000 sec.-ft.; and (3) increasing the slope from 1.82 ft. per mile to 3.20 ft. per mile.

An estimate of the quantities involved in the works indicated, exclusive of the Caballo Dam, which is considered separately, is as follows: levee embankment 8,985,000 cu.yd.; channel excavation, 4,775,000 cu.yd., and right-of-way 4,075 acres from each country. The estimated cost of the work is given in the accompanying tabulation.

Basis of estimate

The assumptions on which the estimates are based are briefly as follows:

Caballo Reservoir—The cost of the Caballo Dam, including the purchase of the lands to be submerged, has been estimated by the Bureau of Reclamation at about $1,250,000 for the 100,000-acre-ft. capacity.

Segregated Tracts—In order that neither nation shall sacrifice national area, it is required that the total land to be segregated or cut off from one country shall equal that to be segregated or cut off from the other. On the accompanying Fig. 1 these tracts aggregate 59 cut from Mexico and 65 from the United States. Their areas vary from 0.25 acres to 377 acres. The approximate total area to be cut from each country is 3,460 acres.

San Elizario Island—Two alternate routes for the location of the rectified channel along the San Elizario Island are shown by Fig. 1. One route follows in a general way the present river, while the other follows in a general way the present boundary. The two routes are almost identical in length, and have practically the same gradient and grade elevation.

The boundary route is estimated to cost about $75,000 more than the river route, due largely to the higher value of the lands required for the right-of-way and the segregated areas, and to the disestablishment of some of the irrigation and drainage works now constructed in the United States with the river in its present location. The equalizing of all the segregated tracts and the estimate submitted herewith both are based on following the boundary route along the San Elizario Island.

The requirements of the project indicate two important limiting velocities—

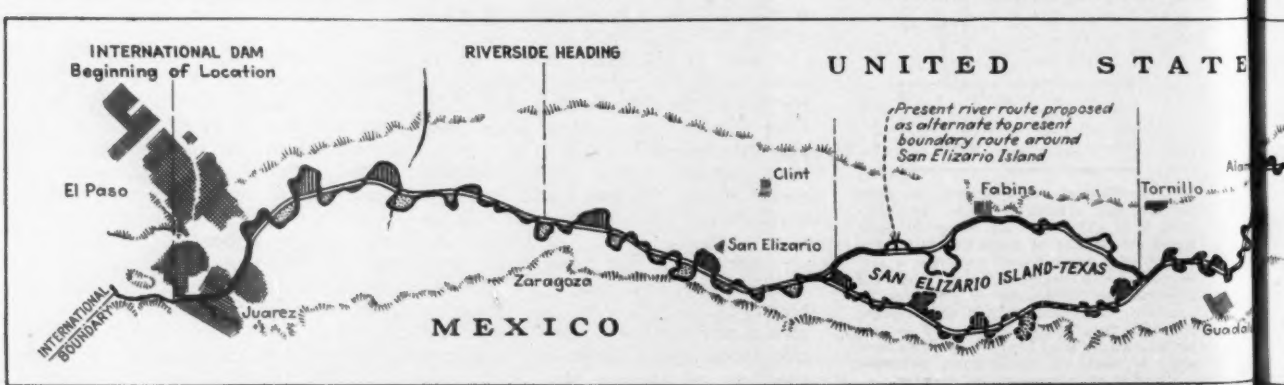


Fig. 1—Proposed rectification of the channel of the Rio Grande for 155 miles through the El Paso-Juarez Valley. Shaded areas show interchanges of land between Mexico and the United States. Present 155-mile channel is shortened by rectification to 88 miles.

namely, that the maximum velocity in the flood channel at full flow must not entail expensive bank protection, and that the minimum velocity in the normal flow channel must be high enough to carry the annual increment of sand and silt to prevent channel upbuilding.

The increase in average gradient, from 1.82 ft. per mile to 3.2 ft. per mile, will produce velocities of 5 to 6 ft. per second at full flow. These velocities can be safely carried in the channel designed where the alignment is reasonably straight and the cross-section relatively wide. The data on normal flow indicate that the low-water channel will have a velocity of around 3 ft. per second.

The value of n in Kutter's formula

Fig. 2—Typical cross-sections of floodway proposed for Rio Grande channel improvement through El Paso-Juarez Valley.

adopted for use on this project is n = .025 for the normal flow channel and n = .030 for the flood channel. These values follow closely those determined on the Miami Conservancy District at Dayton, Ohio, taking such tests as are believed nearly to duplicate the conditions to be encountered on this project.

The cross-sections adopted as best suited to the requirements of the project are shown by Fig. 2. The proposed cross-section has levees spaced 590 ft. apart, with levee heights of about 7.2 ft. In actual construction levee heights will vary from nothing, where bench lands are encountered, to 15 ft., where the old river channel is crossed. The levee section proposed has a 16.4-ft. crown, with side slopes of two to one. This will permit the use of the top as a road for inspection and repair.

The normal flow channel is designed with a bottom width of 66 ft., as this channel width seems to fit the present channel width of the river best. Side slopes are 1:1 except throughout the lower section, where 2:1 slope is proposed on the side adjacent to the left levee.

Gradients vary from 2.38 ft. per mile to 4.26 ft. per mile, and the levee heights have been changed to conform, always adding 2 ft. as freeboard. The estimated capacity below the 2-ft. freeboard varies from 10,700 to 11,500 sec.-ft.

The total right-of-way required is 8,160 acres, equally divided between the two countries. In addition to the land actually occupied by the works, a strip 49 ft. wide outside the land toe of each levee has been included for use in levee maintenance or possible future levee widening.

All earthwork of both channel excavation and levee embankment is planned to be accomplished by machine methods, and the unit cost used in the estimates is 18c. per cubic meter, which is about that developed on similar work in that locality. The machines best suited to the work are draglines equipped with 100-ft. booms, with buckets from 2 to 3 cu.yd. in capacity, although on a great part of the levee work smaller equipment can be used economically.

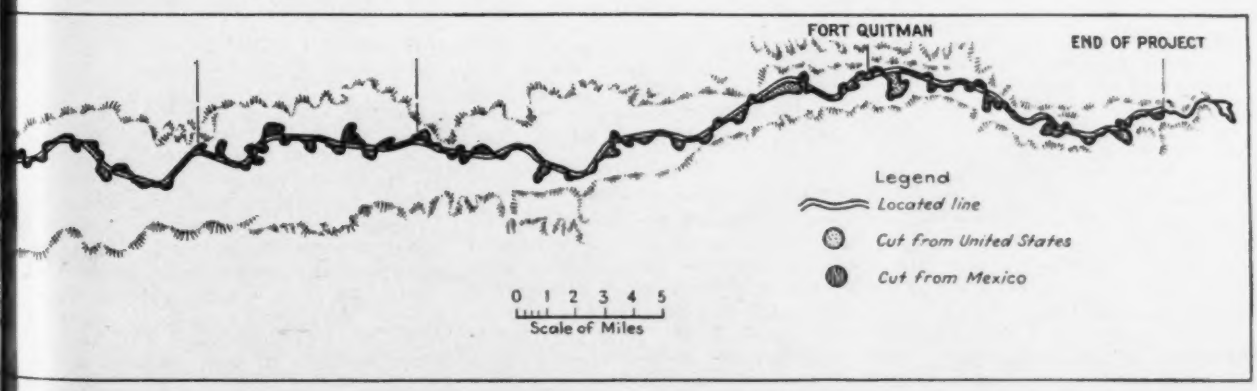
Because the effects of the introduction of steeper gradients in the river channel are problematical and considerable scour may develop, and because the irrigation supply must be diverted at certain places, there has been set up in the estimate an amount of $675,000 for grade-control structures. An allowance of 20 per cent has been added to cover the cost of engineering, contingencies and ovrehead.

The report is presented by L. M. Lawson, commissioner; C. M. Ainsworth, consulting engineer; Clark W. Creps, secretary, all for the United States; and by Armando Santacruz, Jr., commissioner; Joaquin A. Bustamante, chief engineer; and Jose Hernandez Ojeda, secretary, all for Mexico.

RIVER RECTIFICATION—EL PASO-JUAREZ TO QUITMAN CANYON. ESTIMATE OF 11,000 SEC.-FT. CHANNEL

Right-of-Way		
Mexico: 4,080 acres at $20	$82,500	
United States: 4,080 acres at $81	330,000	
		$412,500
Segregated Tracts		
Mexico: 3,460 acres at $16	56,000	
United States: 3,460 acres at $60	210,000	
		266,000
Earthwork		
4,775,000 cu.yd. at $0.138	657,000	
8,985,000 cu.yd. at $0.138	1,236,600	
		1,893,600
Clearing		
6,000 acres at $25.30		150,000
Miscellaneous		
Work above Cordova		
Mexico	$25,000	
United States	100,000	
Changes in irrigation works:		
Mexico	75,000	
United States	150,000	
Grade controls (6)	675,000	
Bridges (6)	300,000	
		1,325,000
Sub-total		$4,047,100
Twenty per cent engineering, overhead and contingencies		809,400
Total		$4,856,500
Caballo Dam—100,000-acre-ft. reservoir		1,250,000
Grand total		$6,106,500

NOTE—The smaller unit price of the segregated tracts as compared with the rights-of-way is predicated on the resale value of those segregated.



Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

Two Books on Mechanics

STRUCTUAL MECHANICS—By Harrison W. Hayward, Addison F. Holmes and Ralph G. Adams. Cloth; 6x9 in.; pp. 182; line drawings. Published by McGraw-Hill Book Co., Inc. New York and London. $2.25.

ANALYTICAL MECHANICS FOR ENGINEERS—By Fred B. Seely and Newton E. Ensign. Second edition. Cloth; 6x9 in.; pp. 414; line drawings. Published by John Wiley & Sons, New York, and Chapman & Hall, London. $3.75.

The first of these two books has been prepared for the use of students of a free evening school established by Lowell Institute under the auspices of Massachusetts Institute of Technology. It is a complete revision of a book published several years ago by the late Prof. Harrison W. Hayward.

The book by professors Seely and Ensign is an entire resetting of a first edition published in 1920. Revisions are the result of suggestions of students and teachers and affect chiefly the arrangement of the book, changes made in the interests of simplification. A new feature is the addition of review questions and problems at the end of each chapter.

* * *

Managing Municipalities

CITY MANAGER YEARBOOK 1933—Edited by Clarence E. Ridley and Orin F. Nolting. Cloth; 6x9 in.; pp. 356. Published by The International City Managers' Association, 923 East 60th St., Chicago. $2.

The report of the proceedings of the 1932 Conference of International City Managers' Association comprises the greater portion of the 1933 yearbook of the association. At that conference, held last fall, one of the most important sessions was on the technology of retrenchment, and the yearbook contains valuable papers under this heading by Simeon E. Leland, Carl H. Chatters, O. E. Carr, Lent D. Upson and Calvin Skinner. There are other papers presented under the headings of management technique, police problems, principles of public administration, managerial relations and new aspects of municipal fire prevention. In addition, there are twenty short articles covering the more significant events and developments in 1932 in the various fields of municipal administration. An article on the council-manager development in 1932 points out that more than one-fifth of all the cities in the United States with 10,000 or more population now operate under the council-manager plan. This percentage applies also to cities of over 100,000 inhabitants. Of all the cities over 25,000 that can adopt the manager plan under existing state laws, one-third have done so. This article also traces the growth of the manager plan, cities defeating proposals to adopt the plan, court decisions, legislation and the recent development of the county-manager plan. All the cities and counties of the country now operating on that plan are listed together with the name of the manager.

* * *

Soil Mechanics in Japan

REPORTS OF GEOTECHNICAL COMMITTEE, Research Office, Government Railways of Japan—Bulletin No. 2, October, 1932. Paper; 8x12 in.; pp. 410. Halftones and line drawings. Published by the Research Office, Government Railways of Japan, Tokyo, Japan.

Soil mechanics, both theoretical and practical, is the subject of a series of reports compiled by the geotechnical committee of the Government Railways of Japan as Bulletin No. 2, October, 1932. The text is largely in Japanese, but the subject covered is summarized briefly in an introductory note in English at the head of each report. The subjects covered are generally practical applications of the theories of soil mechanics to railway problems, foundation, culverts and retaining walls in difficult ground and studies of land-slides and other railway accidents. An improved elutriator for the mechanical analysis of soils is described.

Miscellaneous Notes on Booklets and Reprints

COLUMN TESTS being conducted at Lehigh University are the subject of the third and fourth progress report. Circular No. 81, The Institute of Research, Lehigh University, Bethlehem, Pa. Price 20c.

SALVAGING METHODS to prevent needless damage from water during fires is the subject of Bulletin 112, Engineering Experiment Station, Iowa State College, Ames, Iowa. Single copies free.

THE SACRAMENTO - SAN JOAQUIN DRAINAGE BASIN in California for the year 1931 is the subject of an exhaustive report issued in mimeographed form by the division of water resources of that state. The plan is to publish annual records in this form and later to consolidate a five-year record in a printed report. The annual just issued covers conservation measures, streamflow, administration records, measurements and statistics in a book of 218 pp. with 13 plates and 95 tables giving data on such matters as rainfall, runoff, discharge, salinity, evaporation, pumping costs and water use.

A SILVER JUBILEE SOUVENIR VOLUME has been issued by the Mysore Engineers Association, Bangalore, India. The volume describes engineering and architectural development in Mysore State, including irrigation, power and railway work. It is illustrated with numerous halftones and line drawings.

UNIFORM TRAFFIC LAWS are summarized in a pamphlet prepared by the National Conference on Street and Highway Safety (1615 H Street, N. W., Washington, D. C.) for the presentation in convenient form of the salient features of the uniform vehicle code prepared by the conference. Summaries of various motor-vehicle acts, traffic ordinances, etc., are included.

THE STRATIGRAPHY of the Central Basin of Tennessee is the subject of Bulletin 38, division of geology, Department of Education, State of Tennessee, Nashville. Civil engineers will be chiefly interested in the data concerning road metal contained therein. A related paper is a preliminary report on the *Foraminifera* of Tennessee designed to aid those drilling for oil and for water.

CLAY AS AN ADMIXTURE IN CONCRETE is discussed in Bulletin 15, Engineering Experiment Station, Cornell University, Ithaca, N. Y. The paper is by H. H. Scofield, professor of materials, and A. N. Vanderlip, research scholar and assistant in testing materials in the school of civil engineering. The tests were made according to specifications by Hugh L. Cooper & Co., and relate to strength, elasticity and permeability.

A SERIES OF TESTS ON WALLS of concrete blocks and composite-concrete blocks and bricks, using concrete made with several types of aggregate, are reported in Bulletin No. 251, Engineering Experiment Station, University of Illinois, Urbana, Ill. (25c.) The study was made by the experiment station in cooperation with the Concrete Masonry Association, Portland Cement Association and the Western Brick Co.

ANALYSIS OF CONTINUOUS FRAMES by the method of restraining stiffnesses is the subject of a booklet published by W. H. Ellison and Earle Russell, consulting structural engineers, 712 Pacific Building, San Francisco. In it the author presents a method for the analysis of continuous frames or beams in which results are given directly without the use of simultaneous equations or a series of approximations. The book treats members of both uniform and

variable moment of inertia; complete solutions are given for several typical problems. A set of 34 tables is included which give the constants for many different shaped members. The tables may be used directly in the Hardy Cross method of fixed-end moment distribution. 50 pages, $2.

BALANCING THE BUDGET; a statement by a University of Chicago round table on the federal fiscal policy during depression. Public Policy Pamphlets No. 1; The University of Chicago Press, Chicago, Ill. 25c. Four similar pamphlets, "The Economics of Technocracy," "Unemployment Insurance," "War Debts," "Deflation and Capital Levy," are in preparation for distribution on or before March 16. Price for the set of five, $1.

FLOW OF WATER through circular, parabolic and triangular vertical notch weirs is the subject of pamphlet No. 40, Research Series, Engineering Experiment Station, Purdue University. The purpose of the investigations described therein was to determine the relation between head and rate of discharge for a given notch; to develop a general equation for computing the rate of discharge through different notches of given shape; and to compile an abstract of literature on the subject under study. The study was made by F. W. Greve, professor of hydraulic engineering at the university. Copies of the bulletin may be obtained from the university. Price, 50c.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

DER EISENBETONBAU—By C. Kersten. Paper; 5x7 in.; pp. 262; tables and line cuts. Published by Wilhelm Ernst & Sohn, Berlin. 8 RM.

MECHANICAL TRANSMISSION OF POWER—By the late Prof. G. F. Charnock. Paper; 6x9 in.; pp. 148; photographs and line drawings. Published by Crosby Lockwood, Ltd., London. 8s. 6d.

STRUCTURAL ENGINEERING—By John Edward Kirkham, Second Edition. Cloth; 6x9 in.; pp. 759; tables and line drawings. Published by McGraw-Hill Book Co., Inc., New York and London. $5.

INTRODUCTION TO TECHNOCRACY—By Howard Scott and others. Board, cloth back; 6x8 in. Published by The John Day Co., New York. 90c.

WHAT IS TECHNOCRACY?—By Allen Raymond. Cloth; 5x8 in.; pp. 180. Published by Whittlesey House, McGraw-Hill Book Co., New York and London. $1.50.

Letters to the Editor

What Kind of Construction Congress?

Sir—I have read over the reports of the meetings of the highway and building congress in your issue of Jan. 26, and I find them very informative; in fact, I have an impression that a reading of this issue is much more satisfying than attendance at the congress itself.

I should say that the congress was made up of too many elements to permit a community of interests and a coherent expression of needs. I do not believe that a large number of independent organizations can, by the mere selection of a common point for their respective meetings, accomplish the purpose of coordination so essential to concerted action by these various construction industries.

A congress could, I believe, accomplish more far-reaching results if it were made up of definitely accredited delegates from each industry working on agenda prepared and approved in advance and subdivided into sections for the treatment of those questions which are not common to the congress as a whole. This delegate body, when its findings had received the approval of the several industries through action on the reports of the representatives attending, would be a recognized and authoritative medium for translating and emphasizing the needs of industry.

In short, why not have a united states of industry, with legislative and executive machinery to function along representative lines?

New York City,
Feb. 6, 1933.

J. E. PENNYBACKER,
Managing Director,
The Asphalt Institute.

Corewalls in Dams

Sir—I cannot refrain from discussing the article by Louis E. Ayres entitled, "Why Use Corewalls?" (*ENR*, Dec. 29, 1932, p. 786). The rockfill dam illustrated in your paper of Nov. 3, 1932, p. 529, has for obvious reasons no place in American engineering construction. Mr. Harza justly calls it an experiment, and Mr. Ayres is in error in leaning on discussions of this defective dam in order that he may prove a theory.

I felt that the installation of a corewall in the Priest Dam on the Hetch Hetchy Project, 150 ft. high, was a judicious proceeding inasmuch as the dam had to be completed quickly. This corewall is subjected to unbalanced pressures with the reservoir full and the reservoir empty, and provision was made for flexibility by dividing the corewall into panels 50 ft. long by 16 ft. high, which are dovetailed into each other. They were further fortified against leakage by the installation of 16-gage sheet copper in the joints between the panels. About 27 tons of sheet copper was used in the construction of these water stops.

The upstream half of the structure was made by hydraulic fill, the material resting on very flat slopes from the deposited rim toward the corewall. The downstream heel of the dam was made of rockfill for a height of 50 ft. and the remainder of the fill was made by dump cars from steam shovels, the fines next to the corewall being sluiced into place against the corewall by water jets. This dam has survived now for eight years with no serious signs of hardship. The lower portion of the fill below the corewall naturally experienced a settlement, and about 6 ft. of material was subsequently placed on its top to restore levels. The leakage through the corewall is practically constant—about 1½ in. over a 12-in. weir—and is subject to slight modifications by the fluctuating levels of the reservoir.

E. G. Ritchie, chief engineer, Melbourne Metropolitan Board of Works, has made an improvement on my core by introducing a hollow drainage tube at the bottom of his corewall, and he is entirely satisfied with the results of his design.

I do not see the reason for Mr. Ayres' impeaching the merits of the textbook from which he quotes. One does not need to go to Chile to find the sealing of rockfill dams effectively made. They exist on the Dix River Dam in Kentucky, the Bowman Dam, Morena Dam, and Salt Springs Dam in California. It does not clarify the situation to jump from earthfill dams to rockfill dams, as they are two entirely different types of structure, each of which needs special consideration and treatment. The practice of the late Gardner S. Williams is interesting, and it is a very sane policy to drain the downstream portions of earth dams, with or without corewalls.

M. M. O'SHAUGHNESSY,
Consulting Engineer.

San Francisco, Calif.,
Jan. 4, 1932.

Iron Plates for Dams

Sir—I was much interested in the article "Why Not Steel Dams?" by C. M. Stanley (*ENR*, Dec. 1, 1932, p. 652) and his reference to non-corrosive alloys. I would like to call attention to the recent development of iron plates, which now can be obtained in almost any commercial size at a fairly reasonable rate.

The non-corrosive character of this material becomes more and more evident to those who have old iron bridges alongside new steel ones. The steel bridges may require painting every two to four years, while the old iron bridge may not require painting from five to fifteen years except for the sake of appearance. It may look as though it had the smallpox, but there is practically no loss of section.

H. T. RIGHTS,
Bridge Engineer,
Lehigh Valley R.R. Co.

Bethlehem, Pa.,
Dec. 6, 1932.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England.

Subscription price $5 per year in the United States; foreign rates on application.
Copyright 1933 by McGraw-Hill Publishing Co., Inc.

FEBRUARY 16, 1933 Volume 110 No. 7

Prompt Action Is Vital

The plan for unified action of the construction industry that was inaugurated at last month's highway and building congress has not yet been put into execution. Immediate progress is vital to the success of the plan. The task of getting action under way must be accomplished, at least in the preliminary stage, by the working committees that the congress sets up. It is highly important that delay in organizing these committees for work should not dampen the enthusiasm with which the congress espoused the new cause of united construction. Early and definite conclusion of the committees' work is needed to confirm and crystallize the convictions of the congress and to convert the remaining hesitancy of some interests into active support. Fortunately, the committee organization adopted permits of realizing exceptional speed of action; a steering committee of three to develop a plan and program of action and a larger reviewing body to stamp the accepted program with the authority of the congress bodies constitute efficient means for rapid progress. These means should be utilized without delay.

Clear Thought on Railroads

The report of the National Transportation Committee, issued as we go to press, brings constructive thinking to bear on one of the country's largest current problems, the virtual bankruptcy of the railroads. It points to the burdensome financial structure of rail transport systems, to the need for consolidation of lines, to the passing of the need for competition between lines while regulation is effective, and to the necessity of combining highway and water carriage with rail carriage. It sweeps away, as did the findings of the joint rail-highway group two weeks ago, the demand that road transport be so taxed as to enable the railroad to compete. And finally it points to the unsound practices that have become established in waterway development, and demands that waterway development be undertaken only where it is self-supporting—the St. Lawrence to be the first application of this rule. These sensible findings invite general assent. Since they also dovetail closely with the findings of recent studies in other countries, they offer hope of laying a foundation on which a sound revision of the railroad system can be built.

Levee Building Makes a Record

Tardiness in adjusting the disputed details of the Mississippi flood-control plan has had no reflection in the execution of the operations agreed upon. Levee building has proceeded with a speed that sets new earth-moving records. The 83,000,000-cu.yd. placement of levees below Cape Girardeau during the six months of 1932 exceeds the volume of work done in any preceding full year, and makes the biggest year's record of the Panama Canal (30,000,000 yards) look almost insignificant. Credit for this achievement is divided between a number of agencies. The capable directing organization of river engineers has been effectively supplemented by the development of a notable group of trained levee contractors and by the mechanization of operations to a superlative degree. Both men and equipment have contributed to the new levee-building records.

Economy in Close Design

That rule-of-thumb design methods must yield to more rational procedures when the utmost measure of economy is to be attained in engineering construction is well illustrated by the article in this issue describing the new storm-sewer system for Dallas, Tex. In determining the amount of drainage to provide for in the new system, an elaborate analysis of hydrologic conditions was made to assure the greatest possible usefulness for the least cost. Runoff coefficients were experimentally determined for the expected operating conditions; storms in summer, when Dallas ground is quite pervious, were excluded from the basis of design. Possible damages from occasional overload were found to be less costly than providing capacities for maximum rainfalls, and the system therefore was designed for storms to be exceeded once in five years. Finally, existing watercourses were utilized where possible. As a result of the study, a workable drainage system was built at low cost.

Cement or Aggregate?

Whether high-lime cement or unsound aggregate is at the bottom of some perplexing damage to concrete pavements in New York State has been under active discussion for some years. Light is thrown on the matter by Ira Paul's report of service records that point toward responsibility of the cement, apart from possible contributing effect of the aggregates. Since there is abundant evidence also to show that unsound aggregates have found their way into New York's road pavements, the matter becomes particularly interesting. But Mr. Paul's case against high-lime cements is so direct as to demand consideration. It adds to arguments of other character, such as those on heat generation, to suggest a return to the rather different balance of composition that prevailed in earlier years. Further study of the problem is therefore warranted.

Utilizing New Materials

The notable use of aluminum booms for levee dragline excavators described last week is typical of machinery advance in flood-control work as well as elsewhere. By carefully studied adoption of new materials and design forms and modern motive-power devices, the mobility, operating speed and radius of all equipment used in levee construction have been multiplied. Aluminum booms represent a successful effort to increase working radius without adding to weight or cutting down operating speed. Similarly the equipment designer has turned to new metals or metal alloys to obtain greater resistance to wear. These more expensive metals have brought with them new creative thought in assembled instead of single-piece equipment units. The buckets with aluminum bowls for lightness, and digging lips and teeth of high carbon or alloy

steels for resistance to wear, described in the article previously referred to, are examples. So a new practice in machine design is growing out of the adoption of special metals. Welded construction and new types of power units are powerful contributing influences to this change. Equipment engineering merits high tribute in any appraisal of construction progress.

Parkway Possibilities Through the evolution of the suburban radial parkway a new freedom is coming to large cities. In its normal growth the city is increasingly walled about by obstacles which this very growth creates; the radial parkway pierces through these obstacles and ties country and city together in closer bond. It is more than a thoroughfare, for by extending the open spaces and their vegetation through the barrens of the subdivider's domain it does something quite beyond mere traffic service. It is a costly device, but the advantages gained are large enough to outweigh the costs, as witnessed by the increased value of property in such a region as Westchester County, New York. Little reflection is required, then, to assure us that parkway development will have a large future. No major city can hope to preserve its civic and economic health unless it cuts through its constricting band and gives its central regions access to light and air. Efficiently done, the process is capable of counteracting the core decay now so painfully apparent in most cities of size. But efficiency demands long preparation, as may be seen from the history of the Grand Central Parkway, New York trunk entrance of the Long Island system. Radial parkway planning, therefore, claims early consideration as an essential of community programming both for cities and for entire regions.

Rio Grande to be Straightened The troublesome flood problem of the Rio Grande in the irrigated valley extending a hundred or more miles east from the border cities of El Paso and Juarez is advanced a long step toward solution by the preliminary agreement of agents of the United States and Mexico on the river regulation plan proposed by the International Boundary Commission. As outlined in this issue, the plan has special engineering interest as perhaps the most extensive river-straightening operation that has been definitely adopted by American engineers. The shortening by more than 40 per cent of a heavily silt-loaded alluvial stream, which will increase its slope from 1.82 to 3.20 ft. per mile, is a bold proposal in the face of the long-standing engineering tradition of the inviolability of stream regimens established by nature. The proposed straightening plan, however, has to be considered in the light of several influencing factors. The first is flood reduction by a new dam, above El Paso. The second is the artificial flattening of slopes by the diversion dams in the upper river and by six to ten slope-control structures spotted through the lower valley. These devices remove in large measure the presumed hazards of increased slope and reduced channel length. Furthermore, a scouring current is wanted. In short, whatever opinion of straightening in general may be warranted, the safeguards in the proposed plan seem reasonably adequate. Politically, the straightened and controlled channel will assure both countries of relief from many difficulties and will go far in stabilizing the value of land holdings throughout the irrigated valley.

Engineering Goes On

IN A SURVEY of the present serious difficulties of industry and the worker, before the American Association for the Advancement of Science, Dexter S. Kimball, dean of engineering at Cornell University, confounded the many critics of human progress whom the stress of the day has brought forth. He showed by facts and figures that there is no reason to read misfortune out of technological advance or to lay responsibility for economic disaster at the door of the engineer. He pointed out the significant fact that with all the multiplication of productive power during the last half century the number of workers and their income increased.

Dean Kimball found no indication that we must expect a halt in progress, whether of invention or of productive efficiency. Perhaps the latter is reaching the stage of diminishing returns, in automaticity of the shop as well as in such matters as railroad speed and transmission of intelligence; but increased efficiency, more capable engineering and the creation of new things will go on without interruption. Humankind is ever struggling onward, and each gain in science or in technology increases the certainty of further advance.

We need the inspiration of such words. And we need the help of the message that was given to a Mid-West audience in a radio address two weeks ago by Willard Chevalier, publishing director of *Engineering News-Record*. He told his hearers that the future of engineering lies in the vast field of work still to be done before physical and human resources will be used effectively:

> "The objective toward which we all are working is a higher standard of comfort and living for all of us. But it will be obvious that this can be realized only as we continue to increase our production of every kind of wealth. Only as we increase the capacity of each of us to produce the goods and services we require can we hope to raise the general standard of living. There is no other way.
>
> "Once we have adjusted the present discrepancy between productive power and exchange capacity, the need for the engineer's services will increase rather than diminish. The destiny of America is tied up with the progress of engineering science. Our cities have not reached their ultimate size, our natural resources are not yet exhausted, our land areas are not yet populated to saturation. We shall continue to grow, and we shall continue to build more of every convenience and facility."

In short, the future of engineering, if it can be measured at all, is to be gaged not by the past but by the problems still unsolved and the possibilities yet to be explored. Engineering, the greatest servant of progress that humanity has brought into its employ since the world began, is no less useful and potent today than in the past. Just as it was the agent that transferred toil from muscle to machine and that overcame nature's obstacles and hostile forces, so it will have to coordinate its results with the needs of society. Much needless toil still remains. But it is through our own misadjustments, our failure to control distribution of production and credit, that we waste and want, and fail to realize the leisure we have won.

Engineering will have to deal with many problems lying outside the field of craftsman technique. It may have to measure men's wants and needs and proportion industry's work to suit; it may have to forecast the evolution of cities and states in order to plan construction requirements intelligently; it may have to provide assurance against the blight of idleness and old age. Whatever its problems, they will be commensurate with the advance of social order, prosperity and civilization.

NEWS OF THE WEEK

St. Lawrence Treaty Favorably Reported by Senate Committee

A FAVORABLE report on the proposed treaty between the United States and Canada for the development of the St. Lawrence waterway was made to the Senate foreign relations committee by its subcommittee on Feb. 10. The committee vote was five to two in favor of the treaty, with a reservation providing that "nothing in the treaty shall be construed as confirmation of any claims of the right to divert water of any sort."

The committee's favorable report was made after representatives of the New York State Power Authority and engineers of the War Department had agreed on recommendations as to the share of the cost of the work to be borne by New York.

Agreement on cost distribution

The distribution of cost between the United States and the state of New York recommended to the Senate committee by the army engineers and the representatives of the New York State Power Authority is as follows: (1) The United States to assume responsibility for the cost of all work for navigation; (2) New York to assume $23,500,000 as its share of the cost of work common to navigation and power, provided that if the actual cost of construction is less than the estimated cost the amount for which New York is liable will be reduced by its proportionate share of such savings.

(3) New York to assume responsibility for $29,295,500 as the estimated cost of its power house substructures, head and tailrace excavation; reservations as to reduced cost savings as above are included.

(4) New York assumes responsibility for the actual cost of its power house superstructures and equipment, estimated at $36,930,500, and may elect to construct any or all of these works through its own agencies.

(5) In the event that the state of New York elects, the United States will assume responsibility for the construction of the works in their entirety at a cost to New York representing the sum of the cost above set forth, or a total of $89,726,000, provided that New York share in the benefit from any saving.

On the basis set forth in the above proposed agreement, the estimated cost to the United States for work in the International Rapids section becomes $125,765,250.

The above recommendations are based on the assumption that the state of New York shall have the right to utilize for power all the flow of the St. Lawrence river in the International Rapids section allocated to the United States by the treaty other than that required for navigation, together with title to the power works and the land on which they are situated which may be necessary and convenient for their operation.

Housing Project Under New Law Proposed in Cleveland, Ohio

The first housing project under the new Ohio law to be advanced beyond the plan stage has been organized in Cleveland, and funds for construction are being sought from the Reconstruction Finance Corporation. The $5,000,000 project, to be undertaken by the Shaker-Southington Co., calls for the erection of two or three large apartment buildings on an 11-acre tract at the edge of Shaker Heights on 132nd St. The sponsor and promoter of the project is George R. Dall, building contractor. Fox, Duthie and Foose are the architects.

The project is designed to accommodate 922 families, and will provide modern apartments in fireproof and soundproof buildings. No design details are as yet available. The buildings alone will occupy but 23 per cent of the land, the remainder to be turned into children's playgrounds, tennis courts, indoor baseball diamonds and other recreational facilities.

Two-thirds of the cost of the project will be sought from the Reconstruction Finance Corporation. The other third is to be provided by local capital.

Engineering Institute of Canada Holds Annual Meeting in Ottawa

WITH more than 200 delegates from all parts of Canada in attendance, the 47th annual convention of the Engineering Institute of Canada was held at the Chateau Laurier in Ottawa, Feb. 7-8. Hydro electric development formed the general subject of several of the papers read. A description of the Chats Falls development on the Ottawa River was given by T. H. Hogg. Construction features of the large-scale development were given by H. L. Trotter and James Dick, while information relative to hydraulic and electrical features was furnished by O. Holden, E. T. J. Brandon, G. D. Floyd and J. J. Traill.

Trans-Canada highway

One of the most interesting and timely subjects dealt with was a paper on the Trans-Canada highway as an unemployment relief measure, by James Sinton, chief engineer of the Ontario Department of Northern Development. At the outset, Mr. Sinton stated that the results far exceeded the expectations both of those who sponsored and those who organized the undertaking. During the fiscal year ending Oct. 31, 1932, the total expenditure on the Ontario portion of the highway was $6,070,193. The peak employment last winter was 12,500. The first winter's work was discontinued on April 30, 1932. As, however, many of the single men and transients employed were absolutely homeless, both federal and provincial governments decided to permit these young men to remain in camp working eight hours per day for their board and an allowance of $5 per month. Under this scheme over 3,000 men remained on the work from May to October, 1932. With the approach of winter it was decided to carry on the board camps and increase the allowance to $10 per month so as to enable the men to equip themselves with winter clothing. Over 9,000 men are taking advantage of the camps and this number is at present employed on Trans-Canada Highway work in Ontario.

The airplane and aerial camera were effectively used in the location of new portions of the highway and these aids proved great timesavers. In the hurried location work advantage was taken of the information available in the Topographical Survey of Canada, where aerial photographs were procured. Lines were established from the air using Ontario Department of Forestry planes and the probable route was sketched on an air map. In the Kenora district particularly, where most of the air work was done, engineers following up on ground location found that only three miles out of 150 varied greatly from the line established from the air.

Creation of a national service corps, voluntarily recruited from all classes of the unemployed, was proposed by G. MacLeod Pitts, Montreal architect. Mr. Pitts stated that unemployment was a national emergency and should be treated as such. The corps as outlined would include technical and semi-technical men, unskilled laborers and skilled artisans. The government would provide for the complete maintenance of the individual and men of special qualifications would be entrusted to plan and supervise the scheme. Large economies are believed to be possible through the application of this system of carrying on public work.

Other subjects considered

Other papers given included Development of Churchill as a Port, by D. W. McLachlin, engineer in charge of the Hudson Bay terminus, and Hydraulic Stability, by A. W. F. McQueen.

In his presidential address on "Canada's Position in Empire Mineral Development," Dr. Charles Camsell, stated that the deficiencies of the dominion in mineral products were mainly in iron ore, high-quality coal and petroleum.

Olivier O. Lefebvre, of Montreal, chief engineer of the Quebec Streams Commission, was elected president of the Institute for the ensuing year. Other officers elected were: vice-presidents, R. S. L. Wilson, Edmonton, Alberta, and Ernest Brown, Montreal. P. L. Pratley, of

Montreal, was reelected treasurer, and R. J. Durley, of Montreal, secretary.

The secretary reported that although the society had suffered losses in both membership and income during the year, it had been able to maintain its services satisfactorily, even increasing them in some instances. Membership declined from 4,715 to 4,369.

Bids Called for Piers and Steel of San Francisco Bay Bridge

Bids for the most of the substructure and superstructure of the San Francisco-Oakland Bay bridge have been called by the California Department of Public Works. Bids are to be received Feb. 28, March 2, March 7 and 8. They include the superstructure and substructure of both the east and west bay crossings, west approach spans and works on Yerba Buena Island except steel superstructure.

Michigan City Seeks Loan for Harbor and Park Work

Application for a loan of $330,000 has been filed with the Reconstruction Finance Corporation by the Michigan Committee for Trade Recovery for the municipality of Traverse City, Mich. The loan is asked to finance construction of the municipal harbor and park development, a proposed self-liquidating project including a yacht harbor protected by a rock-filled breakwater; open and covered boat wells; marine equipment for lifting boats to winter storage and winter storage for 90 boats; pier 200 ft. wide and 400 ft. long surrounded by a marginal wharf; boat house; casino and Italian gardens; band stand; museum; convention hall and auditorium; grading and landscaping the complete project as part of Clinch Park. The project was designed by Giffels and Vallet, Inc., engineers and architects, Detroit.

Bridge at Straits of Mackinac Proposed as R.F.C. Loan Project

Construction of a bridge across the Straits of Mackinac to join the upper and lower peninsulas of Michigan, again has been proposed, this time as a measure for unemployment relief, to be financed by the Reconstruction Finance Corporation. A thorough inquiry into the feasibility of the project is planned by the Michigan Legislature and a public hearing has been announced by the chairman of the House committee on roads and bridges.

Proponents of the bridge, which is estimated to cost from $30,000,000 to $50,000,000, suggest that it be made self-liquidating by levying tolls. Officials of the state highway department believe the project to be impracticable from an economic standpoint, claiming that the present revenue from state ferries across the straits is only about one third of interest requirements on the loan.

A total distance to be spanned at the narrowest part of the straits is five miles and of this distance about 14,000 ft. is in water less than 40 ft. deep. It is proposed to cross the shallower depths with a solid fill, spanning greater depths of water with a bridge resting on piers and with one suspension span 2,200 ft. long.

O. O. Lefebvre, Quebec Engineer, Heads Engineering Institute

Olivier O. Lefebvre, chief engineer of the Quebec Streams Commission, Montreal, Quebec, was elected president of the Engineering Institute of Canada at its annual meeting held in Ottawa, Ont., Feb. 7-8.

Mr. Lefebvre is a native of Quebec and a graduate of the scientific department of Mount St. Louis College and of the Ecole Polytechnique of Laval University, Montreal, in 1902. He began active engineering work in the cement-testing laboratory of the Public Works Department in Ottawa and after three years there served as assistant to the district engineer of the department at Ottawa from 1905 to 1912. In this position he was in charge of bridge, wharf and dam construction at various points in the dominion and also made a complete survey of Burrard Inlet and of False Creek at Vancouver.

Olivier O. Lefebvre

In February, 1913, Mr. Lefebvre was appointed chief engineer of the Quebec Streams Commission and since that time has directed the extensive activities of that commission in its river regulation work throughout the province.

Recently Mr. Lefebvre served as a member of the Joint Board of Engineers which prepared the report upon which the pending treaty for the development of the St. Lawrence River is based.

Applicants for R.F.C. Loans Meet With Difficulties

Two applicants for construction loans from the Reconstruction Finance Corporation have run into unexpected difficulties. In Louisiana, where the State University proposed to borrow $1,250,000 for the construction of dormitories, a contracting firm has started an injunction suit to keep the university from borrowing the money. The firm claims that as the university still owes it for work done nearly $300,000, represented by certificates of indebtedness, and holds that the borrowing of additional money would endanger its chance of collecting that debt. In Florida the state supreme court has declared invalid the franchise of the Overseas Bridge Co. The company sought a $12,000,000 loan for a causeway to Key West.

Washington Notes

By Paul Wooton
Washington Correspondent

THE Goss bill to require contractors on government work to submit with their bids a list of subcontractors and material men was defeated in the House on Feb. 7.

Highway-aid bill pushed

STRENUOUS efforts are being made at this writing to force a vote in the House of Representatives on the highway authorization bill, which passed the Senate June 8, 1932. Three days later it was reported favorably to the House by the Committee on Roads but the House leaders have refused to allow a vote on the bill.

Relief Act amendment

THE Wagner Bill to amend the Emergency Relief and Construction Act of 1932 as amended by the subcommittee of the Senate Committee on Banking and Currency increases the amount of money for direct relief from $300,000,000 to $600,000,000, provides $50,000,000 for the use of the states for the relief of needy transients and their rehabilitation in training and work camps and changes the wording of the section relating to loans for public works by eliminating the self-liquidating requirement and substituting therefor the requirement that the projects are "needful and in the public interest."

The section relating to loans to private corporations for self-liquidating projects is expanded to include "aircraft suitable for overseas transport and port facilities essential thereto, bridges, tunnels, docks, viaducts, waterworks, canals and markets, devoted to public use and which are self-liquidating in character." The limitation against supporting projects financed by the R.F.C. by taxation is removed. The interest rate is set at "a rate not exceeding one-half of one per cent more than the rate of interest established for the last issue of bonds of the United States preceding the making of such loans."

Private practice favored

SPECIFIC recommendations that government construction agencies confine themselves to general administration and put the work in the hands of private architects, engineers and contractors were presented in a report to Congress last week by the Shannon committee, which since last June has been investigating government competition with private business.

The committee recommended centralization of all architectural supervision and endorsed the Green bill directing the Secretary of the Treasury to contract at established rates of compensation for outside service on architectural and engineering design on all buildings costing, with the site, more than $50,000. The same principle, said the committee, should be followed by the Supervising Architect's Office and other government departments in employing engineering assistance.

The committee recommended "for reasons of economy" that the Army Engineers, the Reclamation Service and other construction agencies "should, so far as possible, enter into contracts with private competitive bidders, and discontinue, so far as possible, the performance of work with government personnel and government-purchased equipment."

Tennessee Basin One of Few Regions With Basic Study

Washington Correspondence

AS a result of an expenditure of over a million dollars for engineering and economic surveys, President-elect Franklin D. Roosevelt, in selecting the Tennessee River basin for intensive development, has chosen one of the few large areas in the country on which the necessary basic studies have been completed. An 8-year investigation by the Corps of Engineers furnished the data. Carrying out the project would cost more than a billion dollars.

Resources of the region

Congress was influenced to appropriate large amounts for this study because of the unusual resources of the region, an area of 40,000 square miles with great agricultural possibilities and important mineral deposits. There is a fall of 500 ft. in the 652 miles of the Tennessee River's length. The power potentialities of the river long have been recognized. The government's survey developed that more than 4,000,000 firm horsepower can be developed in the basin with the aid of auxiliary steam plants if the full fall of the main river and the greater part of that of the main tributaries are developed. Within the basin there is a total of hydro power that may be developed to a base capacity of 3,500,000 kw. The government's hydro installation at the Wilson dam, 184,000 kw., represents one-third of the present installed hydro capacity in the basin. With the construction of the Cove Creek dam the installation at the Wilson dam could be increased to 450,000 kw. This would provide relatively cheap power for distribution over distances up to 350 miles and for large chemical and other manufacturing operations near the dam.

Navigation improvements

Improvement of the river would provide cheap transportation. The navigation project now being carried forward calls for a depth of 9 ft. from the mouth of the Tennessee to Knoxville and 6 to 9 ft. for a considerable distance up the major tributaries. The recommended plan would require a series of 32 low dams if there were no additional power development. Each high dam that would be built for power development would replace two or more of the low dams. Such a plan would cost $56,000,000 on the basis of low dams with locks 56x360 ft., or $75,000,000 with locks of the dimensions of those on the Ohio River. Regulation of the river practically would prevent floods, which now cause average loss of $1,780,000. Such an improvement as that contemplated in the report would have only a negligible effect on floods in the Mississippi River.

Natural resources abundant

Reserves of coal in the basin amount to 1,835,000,000 tons, phosphate rock 92,400,000 tons, iron ore available for use 169,047,000 tons, zinc ore 45,000,000 tons, bauxite 700,000 tons, asphalt rock 17,000,000 tons, copper ore more than 8,000,000 tons. Many other minerals occur in the area.

Corn is the principal agricultural crop. This had led to the building up of a large livestock industry. Tobacco is the region's principal money crop. The principal other farm products are wheat, oats, peanuts, hay, cotton, sweet potatoes and white potatoes. The lumber production of the basin was estimated in the report to have been 618,000,000 ft. b.m. in 1920. The value of manufactured products, also calculated on the census returns, was $388,376,000.

The Forest Service has made no surveys in the Tennessee river basin but it is known that a vast acreage presents opportunity for reforestation.

Electro-chemical industry

Building up of an electro-chemical industry at Muscle Shoals would be one of the features of any comprehensive scheme of development. This would include production of aluminum and caustic soda. With phosphate rock reserves nearby it probably will become a center of production of phosphoric acid. Much doubt is expressed that Muscle Shoals would become a great center for the production of fixed nitrogen. Even if nitrogen is not considered there is very general agreement that all of the power that can be produced at Muscle Shoals eventually would find a market for public utility use within a radius of 350 miles and for the production of chemicals which require cheap power. Friends of the development envisage Muscle Shoals surrounded by much the same type of industrial development as has taken place in the Niagara Falls region.

Prettyboy Dam Contract: A Correction

In our issue of February 2, p. 154, as part of a report of progress on Prettyboy dam of the Baltimore water supply system, the following statement was made: "Construction has been delayed by poor rock conditions at one abutment requiring much additional excavation and some changes in plans, and by failure of the original contractor."

We have been advised by the contractor that the last clause of the above statement is in error.

We regret that such an error should have been made and wish to take this opportunity to correct it and to apologize to the contractor for its having been published.

—THE EDITORS.

Arthur S. Tuttle Retires; Consultant to New York City

Arthur S. Tuttle, former chief engineer of the Board of Estimate and Apportionment of the city of New York, and since 1928 its consulting engineer, has retired after nearly 48 years of service with the city of New York.

Mr. Tuttle is a graduate of New York University in the class of 1885 and immediately following graduation entered the service of the former city of Brooklyn as a rodman on water-supply work on Long Island. In this work he rose to the position of principal assistant to the engineer in charge. In 1901 Mr. Tuttle left the city service for water supply and irrigation work in Hawaii but returned to the city service to become assistant engineer to the Board of Estimate. Subsequently he rose to the position of deputy chief engineer and then to chief engineer. In his capacity as chief engineer of the board Mr. Tuttle has served on many important committees, notably the one which negotiated the agreement between the New York Central and the City of New York providing for the elimination of the New York Central tracks from the streets on the west side of Manhattan Island.

Mr. Tuttle is the inventor of the Premier water meter, also of a valve for the removal of air from water mains.

Brick Manufacturers to Promote Reinforced Brick Construction

THE Common Brick Manufacturers Association went into its 16th annual convention in Washington last week and came out as the Brick Manufacturers Association. Most of its members now manufacture face brick and a variety of other clay products. Looking forward to the new year with some optimism, the brick makers will concentrate on the market for low-cost homes and for reinforced brick masonry in buildings of all kinds.

Because walls represent less than 20 per cent of the total cost of a brick house, the brick makers have developed innovations in plan as well as construction to find economies. The association now has designs for a house costing $5,000 or less that, by lifting the basement out of the ground, eliminate 80 per cent of the foundation cost. Development of interior floor and wall spaces to eliminate plastering will be followed by experimentation with colors. A sample house now is being built at the Chicago Century of Progress Exhibition.

Reinforced brick masonry is competing successfully with other types of construction, according to reports submitted to the convention. This year the association will conduct a traveling school for consulting engineers throughout the country in which a short course in the design and construction of reinforced brick masonry will be given. Reinforced brick masonry was a feature of 47 jobs that were either started or completed during the past year. The list includes the Department of Justice building and central heating plant for the Mall development in Washington.

The board of directors adopted, in principle, the platform which commanded the united support of the Highway and Building Congress in Detroit in January.

The roster of officers unanimously re-elected to serve during 1933 is composed of the following: President, William Schlake, president, Illinois Brick Co., Chicago; vice-president, W. Gardner Long, treasurer, New England Brick Co., Boston; treasurer, Ernest S. Barkwill, treasurer, Cleveland Builders Supply Co.; secretary-manager, Ralph P. Stoddard. The attendance of 150 delegates was larger than at last year's convention.

Public Works and Private Aid Proposed in Canada

IMMEDIATE launching of a program of public works construction and the setting up of a government commission to finance private construction was proposed at a three-day meeting of representatives of the principal organizations in the construction industry of Canada held in Toronto, Feb. 6-8. The conference also advocated the establishment of a National Construction Council to coordinate the activities of the industry.

Direct relief for the unemployed was wholeheartedly condemned as inefficient and expensive. Its continuation, the delegates said, could end only in the bankruptcy of the country. As a substitute they urged that self-liquidating works should be undertaken. This should be supplemented, they felt, by a body created by the dominion government to aid private individuals and corporations to proceed with building programs, either by guaranteeing adequate loans or directly from funds to be appropriated by Parliament.

The meeting was the first in the history of Canada at which every part of the construction industry has been represented. In going on record as favoring its perpetuation as a National Council, the conference has followed the lead of the industry in the United States and Great Britain.

Delegates were present at the conference from the Royal Architectural Institute of Canada; the Engineering Institute of Canada; the Canadian Manufacturers' Association; the Canadian Construction Association; the Trades and Labor Congress of Canada; Canadian Lumbermen's Association; Brick Manufacturers' Association; Canadian Founders and Metal Trades Association; Canadian Hardwood Bureau; Contracting Plasterers Association of Canada; Electric Service League; Structural Clay Tile Association; Canadian Institute of Steel Construction; Canadian Paint, Oil and Varnish Association; Canadian Chamber of Commerce; Canadian Automatic Sprinkler Association, and Canadian Ceramic Society.

Court Holds Milwaukee Infringes Sewage Patent

In an action brought by Activated Sludge, Inc., against the city of Milwaukee, F. A. Geiger, judge of the United States District Court in Milwaukee, on Feb. 7 held that the patents held by the company had been infringed by the city in operating its sewage-treatment plant. Two of the patents referred to and held by the court to be valid were issued in 1917, one in 1918 and one in 1921. The plaintiff's claim that the effective filing dates should be considered those of the corresponding British patents, 1913 and 1914, was upheld. The Milwaukee sewage plant using the activated-sludge process was put into operation in 1925.

The court rejected the defendant's claims that the patents were invalid because independent and earlier invention should be ascribed to Harry W. Clark at the Lawrence Experiment Station in Massachusetts in 1912 and 1913, and to Harrison P. Eddy at Worcester, Mass., in 1913.

A fuller report of the decision will appear in these pages next week.

SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, annual meeting, Chicago, Feb. 21-24.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual meeting, Chicago, March 13-15.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Chicago, June 27-30.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chicago, June 26-30.

AMERICAN WATER WORKS ASSOCIATION, annual meeting, Chicago, June 12-16.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Chicago, June 27-30.

ENGINEERS WEEK, Century of Progress Exposition, Chicago, June 25-30.

SEATTLE SECTION, American Society of Civil Engineers, has elected M. O. Sylliaasen, city engineer of Seattle, president of the section. Thomas D. Hunt, engineer of Kings County, has been elected vice-president and M. E. Clark secretary-treasurer.

NEW YORK REGIONAL MEETING, American Society for Testing Materials, New York City, March 8. The Spring group committee meeting will be held in New York March 6-10 with the following committees among those holding meetings: steel, wrought iron, cast iron, corrosion of steel and iron, concrete and concrete aggregates, preservative coatings for structural materials, road and pavement materials, bituminous waterproofing materials.

IOWA ENGINEERING SOCIETY held its 44th annual meeting Feb. 9 and 10 in Des Moines. The Fourth Annual Surveyors Conference was held the day immediately preceding. During the evening of Feb. 8 the Iowa Section of the American Society of Civil Engineers met, hearing Dean Anson Marston speak on "Progress in the Solution of the Mississippi Flood Control Problem." An economic theme ran through the Iowa Society program which covered conservation, challenges to engineers for leadership, county planning and county engineers' problems, new engineering opportunities, the highway situation and R.F.C. John S. Dodds, Ames, is secretary-treasurer.

Personal Notes

A. B. LARSON, assistant engineer in the office of the city engineer of Salt Lake City, has been appointed assistant city engineer.

CLAIR C. JOHNSTON has been appointed head of the Civil Engineering Department of the University of Detroit to succeed the late Prof. DAVID P. GILMORE.

A. S. GUNN, construction engineer, Canadian National Railways, has been appointed right-of-way engineer for the Atlantic region to succeed E. G. EVANS, recently retired.

C. H. HOWELL, for the past four years chief engineer of the J. G. White Engineering Corp., in Mexico City, has been appointed chief engineer of the Middle Rio Grande Conservancy District, Albuquerque, N. M., to succeed J. L. BURKHOLDER, recently appointed general superintendent of construction on the Coachella tunnel project on the Colorado River aqueduct. Mr. Howell is a graduate of the University of Illinois in the class of 1905 and except for six years on railroad location and construction has been in irrigation work, including 12 years with the U. S. Bureau of Reclamation.

LOUIS A. GEUPEL, sanitary engineer for Ulen & Co. on water supply work in Athens, Greece, has returned to Lebanon, Ind. Mr. Geupel remained in Athens to supervise the first six months of operation of the new system.

BENJAMIN R. DAVIS, a member of the engineering department of the Metropolitan District Commission, Boston, since 1897, has been appointed chief engineer of the parks division to succeed the late EDWIN H. ROGERS.

CHARLES E. KNIGHT, for the past six years in charge of municipal engineering in the office of J. French Paddock & Associates, consulting engineers, has been made associate consultant in charge of the Detroit office of the organization.

F. W. WEBSTER, maintenance engineer, Tennessee state highway department, has been appointed commissioner of highways and public works for the state. Mr. Webster is a graduate of the school of engineering of Vanderbilt University and has been with the Tennessee highway department since 1917.

ROBERT H. KINGERY, manager, Chicago Regional Planning Association, has been appointed assistant director of the Illinois Department of Public Works and Buildings by Governor Henry Horner. Until a new director is appointed Mr. Kingery will assume the duties under the title of acting director.

WILLIAM A. MULCAHY, bridge engineer with the Chicago Board of Local Improvements, CHARLES E. DELEUW, consulting engineer and assistant chief engineer, Chicago Bureau of Subways, and ERNST LIEBERMAN, State highway engineer, have been named by the governor as his engineering advisers to survey all departments of the state involving engineering to determine where economies may be effected.

RUBEN E. BACKENHUS, captain, Civil Engineer Corps, U. S. Navy, formerly public works officer at the Navy Yard, New York, has been appointed public works officer of the Third Naval District. Captain Backenhus recently was elected for promotion to the rank of rear admiral to fill the vacancy created by the death of Rear Admiral Frank T. Chambers. Captain CLINTON D. THURBER has been appointed public works officer at the New York Navy Yard.

HORATIO SEYMOUR, Santa Monica, Calif., has been appointed cost and progress engineer for the Metropolitan Water District of Southern California. Mr. Seymour since 1920 has been consultant for the city of Santa Monica on various projects. He was engaged as engineer on the Catskill aqueduct project of the New York water supply from 1909 to 1913 and on subway construction in New York from 1913 until 1918. From 1918 until 1920 he was in the army engineer corps.

E. O. HATHAWAY, for the past 17 years assistant engineer for the U. S. Bureau of Public Roads at St. Paul, retired on Feb. 1 due to ill health. Mr. Hathaway has been succeeded by A. E. PALEN from the Denver office of the bureau. Mr. Hatha-

way went to St. Paul in 1916 following the passage of the federal-aid road act by Congress in order to take charge of the federal government supervision of road work in the states of Minnesota, Wisconsin, North and South Dakota. He is a native of Petersham, Mass., and a graduate of Worcester Polytechnic Institute in the class of 1889.

Obituary

WILLIAM E. STEWART, former city engineer of Covington, Ky., and also of Latonia, Ky., died suddenly at his home in Covington on Feb. 4, age 55 years.

MATTHEW BOUNELL, former vice-president of Ulen & Co., died recently at his home in Newark, Ohio, age 59 years. On account of ill health, Mr. Bounell severed his connection with Ulen & Co. in 1930.

JOHN E. CARTY, engineer in the bridge and ferry division of the city of Boston, died at West Roxbury, Mass., Feb. 5. He was educated at the Massachusetts Institute of Technology and had been in the Boston Public Works Department for 35 years.

WILLIAM N. BLOOD, JR., vice-president, Stone & Webster Engineering Corp., died suddenly at Boston on Feb. 13, age 66 years. Mr. Blood graduated from Massachusetts Institute of Technology in the class of 1888. In recent years he had been in charge of appraisal work for Stone & Webster.

HARVEY E. KEELER, formerly president and owner of the Rogers Park Water Co., before its sale to the city of Chicago, died Feb. 10 at the age of 78 in Honolulu, Hawaii, where he was accustomed to spend his winters. He was an honorary member of the American Water Works Association and treasurer of the Illinois section. Previous to his retirement several years ago he was Chicago representative of the Ludlow Valve Manufacturing Co.

SIDNEY F. LEWIS, member of the State Engineering Board of Louisiana, died in New Orleans on Feb. 8, age 79 years. Mr. Lewis received his engineering degree from the University of Virginia in 1874 and began work with the State Board of Engineers in 1877, continuing in that service until 1908 when he was appointed chief engineer of the Orleans Levee Board. Mr. Lewis was chief engineer of the board until 1916 and in 1920 returned to the State Board of Engineers as a member of the board. He was first president of the Louisiana Engineering Society.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Four Weeks Feb., 1932	Week Feb. 16, 1933
Federal government	$1,869	$5,388	$1,163
State and municipal	9,721	5,526	929
Total public	$11,590	$10,914	$2,092
Total private	9,863	4,591	7,372
Week's total	$21,453	$15,505	$9,464
Cumulative to date:			
1932			$157,941
1933			139,894

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Weekly Average Four Weeks Feb., 1932	Week Feb. 11, 1933
R.F.C. loans made	.....	.....	.....
New capital issues	$15,750	$7,200	$9,400
Total	$15,750	$7,200	$9,400
Cumulative to date:			
1932			$131,500
1933			52,000
R.F.C. self-liquidating loans:			
Approved current week			.....
Approved to date (including 1932)			$172,206
Actual loans made (including 1932)			17,753

ENR Cost and Volume Index

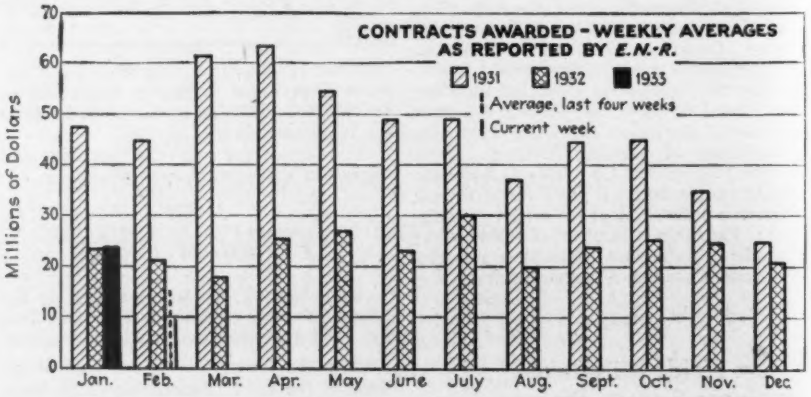
E.N.-R. Cost		E.N.-R. Volume	
February, 1933	**159.30**	**January, 1933**	**120**
January, 1933	158.44	December, 1932	113
February, 1932	161.82	January, 1932	121
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 Average	100		

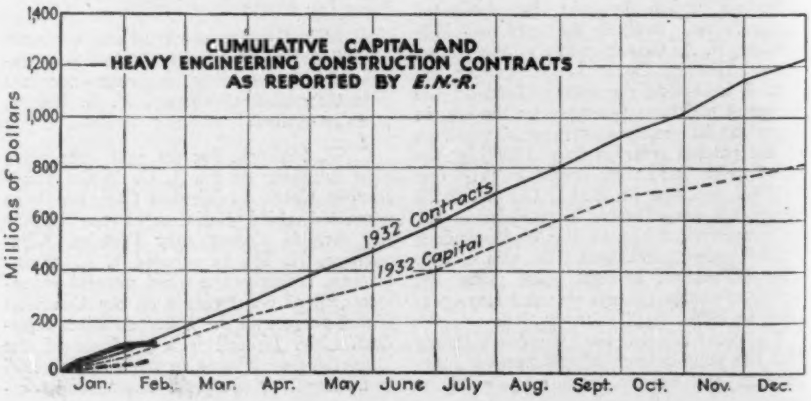
Engineering Contracts and Capital

A SEVERE DROP in state and municipal contract awards, coupled with a slump in federal contracts, brought the total of heavy engineering construction contracts reported for the past week down to $9,464,000, the lowest weekly figure in several years. An unusually large amount of private contracts, amounting to $7,372,000, kept the week's construction figures from making a still lower record. State and municipal contracts amounted to only $929,000, as compared with $4,474,000 the previous week and $12,072,000 two weeks ago. Federal awards were low for the past week with $1,163,000, as compared with $6,077,000 the week before. The average of all contracts let during the past four weeks is $15,505,000, as compared with a weekly average of $21,453,000 for February, 1932. The cumulative total of contracts let to date this year is $139,894,000. Last year's total to date was $157,941,000. Two large private contracts accounted for more than a third of the past week's total. These were the New York Central's St. John's Park freight terminal in New York City, $3,000,000, and a telephone exchange in Raleigh, $1,500,000. There were no large public awards reported. Highway lettings for the past week amounted to only $607,000.

Bids are to be opened the last of this month and early in March for six main construction contracts for the San Francisco Bay Bridge, estimated at $50,000,000. On March 1 bids will be opened for a million-dollar bridge across the Missouri at Omaha. Recent additions to the list of proposed projects of large size include an auditorium at Buffalo, 2 millions; waterworks extensions, including a new dam, Seattle, 1½ millions; and new approaches to the St. Louis municipal bridge, 2½ millions.

New capital issues reported for the past week total $9,367,000, all public bond sales. Among these are three fairly large issues, Cleveland waterworks, $3,200,000; Newark, N. J., parks, $1,200,000; and Utah road bonds, $1,000,000. No R.F.C. self-liquidating loans were reported as approved.

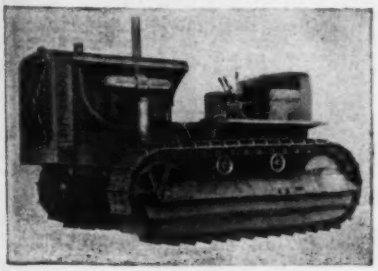




Construction Equipment and Materials

Three New Tractors Announced By Caterpillar

Three new tractors have been added to the line manufactured by the Caterpillar Tractor Co., Peoria, Ill. The new 70, with a maximum drawbar horsepower of 76, is made in two models, one powered by

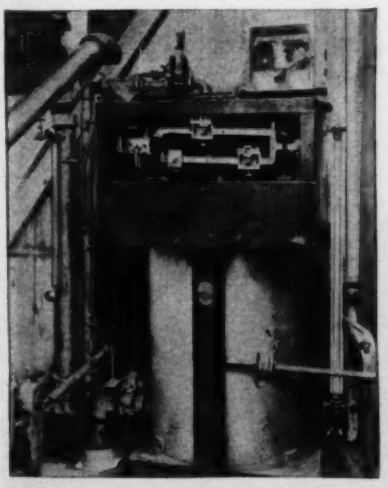


New Seventy Caterpillar tractor

a gas engine and one by a diesel engine. The third new tractor is the Diesel 50, making the Caterpillar 50 now available in either gas-engine or diesel engine drive.

Automatic Weighing Tank For Water in Concrete

A new automatic weighing tank for measuring the water used in concrete mixing plants is announced by the Blaw-Knox Co., Pittsburgh, Pa. Essentially, the unit consists of a cylindrical water tank mounted on a platform scale. The scale is equipped with a double beam, both beams being graduated in gallons. The required number

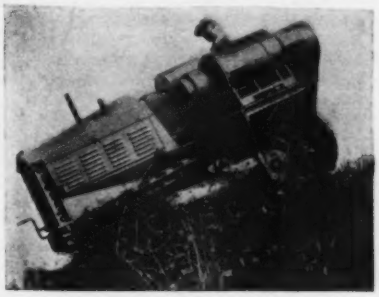


Weighing tank for measuring water used in concrete-mixing plants

of gallons of water is established by means of the poise on the upper beam. Deduction for moisture contained in the aggregate is obtained by setting the poise on the lower beam with the number of gallons of water in the aggregate. The weighing scale is equipped with a springless type indicator which includes an electrical contact so that when the beam is level contact is made and an electrically controlled water inlet valve is instantaneously closed.

Tractor-Mounted Welder

Universal Power Corp., Cleveland, Ohio, has announced an arc welder mounted on a crawler tractor. The welder is driven by the tractor engine and utilizes the shunt inductor principle of arc stablization. The equipment consists of a standard Universal welder mounted on a Cletrac crawler tractor to provide a mobile weld tool of high overall economy. The manufacturer states that the welder mounting does not in any



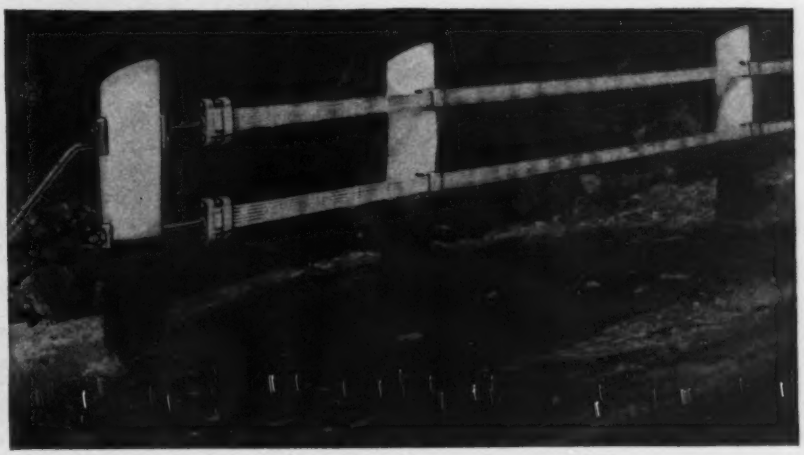
Arc welder mounted on crawler tractor

way restrain full use of the tractor for drawbar work. The whole welder assembly may be easily demounted by removal of a few bolts.

Flat Band of Wires Forms Highway Guard

A new type of highway guard rail has been placed on the market by the Page Steel & Wire Co., Bridgeport, Conn. It is called the Page Traffic Tape. It consists of 21 galvanized steel wires woven into a flat band 2½ in. wide, the wires being held in place by half-round clips woven through them at 6 in. intervals. It can be stretched on existing posts, either round or square, without change. Erection of anchorage, line posts and stretching is similar to that used for cable. Attachment to the post is made with fittings which offset the tape 4 in. to reduce the danger of the post breaking through direct contact with the vehicle. The manufacturer states that due to the bright galvanized finish it is unnecessary to paint the tape when it is first erected. Shipment is made on wooden reels carrying 2,500 ft.

Page Traffic Tape for highway guard



Business Notes

O. B. WILSON, formerly manager of the Cleveland office of the Brown Instrument Co., has been appointed district manager of the territory comprising Texas, Louisiana and southern Arkansas, with headquarters at Houston, Texas.

AMERICAN MANGANESE STEEL CO., Chicago Heights, Ill., announces that Wesley G. Nichols has retired from the presidency and has been succeeded by W. E. Crocombe, who is also president of the American Forge Company.

BUFFALO TANK CORP., Buffalo, N. Y., has acquired the tank and plate fabricating plant of the United Dry Dock Corp., Staten Island, N. Y. The plant has a capacity of about 15,000 tons of fabricated plate work per year.

W. S. SHIFFER has been appointed general manager of sales of the Reading Iron Co., effective Jan. 7, according to information received from the company. Mr. Shiffer has recently been acting as assistant general manager of sales.

CENTRAL IRON & STEEL CO., Harrisburg, Pa., announces that G. Sharpless Eastburn has been appointed assistant general sales manager, effective Jan. 1. Mr. Eastburn has been associated with the General Sales Department of the company for the past four years.

THE WORTHINGTON PUMP AND MACHINERY CORP. recently announced the appointment of Hugh Benet as Manager of its Harrison, N. J. Works. Since 1927, when Mr. Benet became associated with the Worthington organization, he has served as Manager of the Corporation's Holyoke, Mass. Works.

THE GARDNER-DENVER COMPANY, Quincy, Ill., announces the appointment of the Southern Machinery & Supply Company, Roanoke, Va., as agent for its complete line of rock drills and accessories, portable and stationary air compressors, steam and power pumps.

AMERICAN ROLLING MILL CO., of Middletown, Ohio, has acquired the properties of the LAKE ERIE STEEL AND BLANKING COMPANY, Cleveland, Ohio. Lake Erie Steel is engaged in the jobbing of sheets, and specializes in selling sheared blanks for press shop requirements. M. S. Phillips has been made president and general manager of the company.

Vibratory Concrete Tamper

The Electric Tamper & Equipment Co., Ludington, Mich., have announced a new high frequency vibratory concrete placement machine. The device consists essentially of a submergible vibratory motor, flexibly connected to a manipulating handle made in sections of aluminum tubing with a switch on the top section for ease in starting and stopping. The concrete is placed by internal vibration of the mass, causing the material to flow readily to the ultimate point of deposit without segregation or honeycombing. Each batch is consolidated homogeneously with those previously placed. The manufacturer states that concrete so placed will not exert undue pressure on the forms. The device is known as the Vibro-Spade and operates on 110 volts, 3 phase, 60 cycle alternating current.

Vibro-Spade

New Equipment in Brief

Roller. The Galion Iron Works & Mfg. Co., Galion, Ohio, announces the new Galion Chief, a high-speed six-cylinder motor roller. It is capable of a speed of 6 miles per hour. It is equipped with hydraulic steering and has a short wheelbase, permitting the roller to be turned around in less than 20 ft. A differential lock permits locking of both rear wheels together to prevent slipping.

Automatic Pump Control. The Electric Controller & Mfg. Co., Cleveland, Ohio, has announced the new automatic pump control panel designed for use with two motor driven pumps which discharge into the same tank or system. It automatically starts and stops both pumps or either unit alone, if one is sufficient to meet the demand, so as to maintain the tank level or pressure in the system within extremely close limits.

Highway Guards. Tuthill Spring Co., 760 Polk St., Chicago, Ill., has recently incorporated some new features in the design of the Tuthill highway guard. The new guard consists of a 10 in. or 12 in. wide steel rail, convexed, mounted on a flat leaf supporting spring which fastens to the base of the post. The rail sections are overlapped at the spring support and are slotted at one end, with round holes in the other end for ease in assembly and to permit expansion and contraction.

Automatic Air Valve. An automatic air-control valve which permits definitely limited quantities of air to pass, the quantity varying directly as the pressure, has been developed by the research department of the Jeddo-Highland Coal Company. Manufacturing rights have been sold to the Yarnall-Waring Company of Philadelphia, Pa. Designed to prevent waste of air in the operation of pneumatic jackhammers in coal mines, the valve is said to be equally effective for pneumatic tools in foundries and machine shops, for paving breakers working in congested sections where the whipping of a broken or disconnected air hose is a serious hazard, for pneumatic riveters and for other work involving air pressure. When an air tube is disconnected or when a pipe or hose breaks, thereby allowing free discharge of air with a consequent drop in pressure, the valve automatically closes.

Fire Hydrant. The Kennedy Valve Manufacturing Co. announces that it has developed an extension section, by means of which the Kennedy Safetop Fire Hydrant can be lengthened for a raise in street grade by one man, in a short time and without excavating and without shutting off the water service. The construction of the hydrant provides a breakable section which consists of a standpipe breaking ring, which is screwed to the upper and lower standpipe sections, and a stem coupling. If the grade of a street is to be raised, the breaking ring and stem coupling are disconnected from the upper and lower standpipe sections respectively, a standpipe and stem extensions of suitable length are connected on top of the section of the hydrant in the ground, and the upper standpipe and upper stem sections connected on top of the standpipe and stem extensions. Both ends of the standpipe extension are threaded and the ends of the stem extension are drilled. The manufacturer claims that the entire assembly is rigid and as strong as a one-piece hydrant of the same standpipe diameter.

New Publications

Rock Crushing. Monarch Manufacturing Co., Inc., Wilmington, Del., has published an 8-page leaflet describing the "Monco" rock-crushing and allied equipment, elevators, conveyors, screens and washers.

Drawing Filing. A 16-page bulletin describing the Berloy Accoway system of filing blue prints, drawings, maps, etc., has been issued by the Berger Manufacturing Co., Canton, Ohio. The apparatus consists of sheet holders which slide on and off hanger arms. The hanger arm is attached to a channel section by insertion of a removable pin. The pin permits the hanger arm and sheet holder to swing horizontally, allowing quick and free access to the sheets.

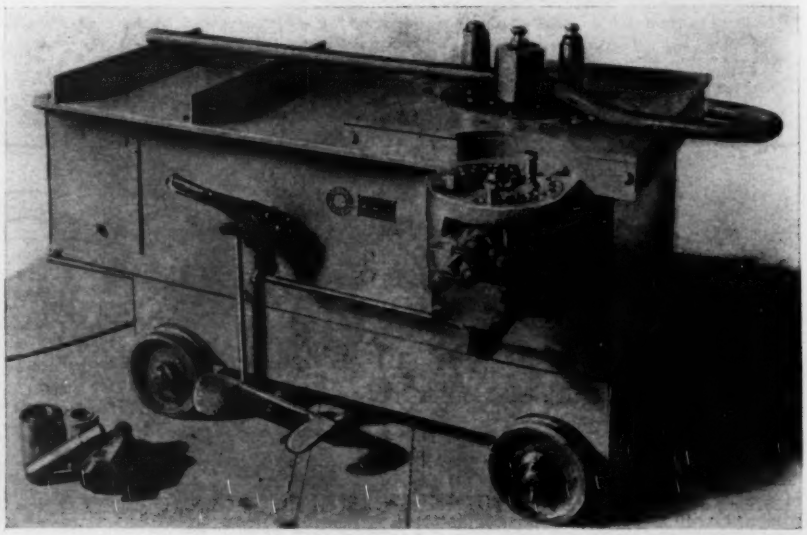
Rubber Bearings. The B. F. Goodrich Rubber Co., Akron, Ohio, has issued an 18-page booklet entitled "Cutless Rubber Guide Bearings as Applied to Hydraulic Turbines." The booklet is profusely illustrated. Included among the subjects treated are oil-lubricated metal bearings, water-lubricated bearings, early uses of rubber guide bearings in hydraulic turbines, spiral-grooved-type bearings, segmental-type bearings and installation of rubber bearings in existing turbines.

Cranes. Whiting Corp., Harvey, Ill., has published a new book on cranes, consisting of 68 pages of pictures and descriptive matter. The book features the Whiting Corporation's complete line of electric and hand-power traveling cranes. The design and construction of the Whiting "Tiger" is described and a number of representative uses are given, including general manufacturing plants, foundry, metal working plant, magnet cranes, bucket handling cranes, railroad cranes, railroad freight terminals, gantry cranes and power house cranes. In addition to these installations there are described special cranes for steel mills, low headroom electric traveling cranes, jib and pillar cranes, low-head hand-power cranes, open-hearth spout-hoist jib cranes and work-car cranes for electric railways. The book is sent free on request.

New Bar Bending Machine Automatically Controlled

A new automatic motor-driven bar bending machine is announced by the G. D. S. Shearing & Punching Machine Co., 101 Walker St., New York, N. Y. The machine is made in four sizes with the smallest one capable of bending bars 1¼ in. round or 1 in. square. The largest machine will bend 2⅜ in. round bars or 1¾ in. square ones.

A feature of the machine is that it is equipped with an automatic arrangement or dial plate on which any bending desired can be pegged and the machine stopped automatically when the bending is completed. Any number of bendings that are to be made consecutively can be set up on the dial plate at the same time. This arrangement means uniformity of product, the manufacturer states, and will accelerate the production of hooks, angles and stirrups. The machine will not only bend a number of bars at one time but will also make several bendings in one operation.

The machine is equipped with wheels to facilitate moving and is entirely inclosed to give maximum protection to the machine operator. The smallest machine is driven by a 1½-hp. electric motor; the other three sizes are driven by motors of 4 hp.

G. D. S. bar bending machine